THE RESISTANCE OF TRAWLER HULL FORMS OF VARIOUS DISPLACEMENT-LENGTH RATIOS AT 0.65 PRISMATIC COEFFICIENT

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Letter on cover:

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WEBB STANDARD SERIES

THE RESISTANCE OF TRAWLER HULL FORMS

OF

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AT

0.65 PRISMATIC COEFFICIENT

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****

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INTRODUCTION

This thesis is a continuation of the development of the Webb Standard Series of high displacement-length ratio hulls. In previous theses presented to Webb Institute of Naval Architecture (1, 2, 3, 4)[1], a parent hull of 0.65 prismatic coefficient was developed. This hull, known as model W-8, has a displacement-length ratio of 300 and a beam-draft ratio of 2.29.

It was felt that the next step in the development of the series should be the expansion of this parent hull. The decision was made to vary the displacement-length ratio, while maintaining the prismatic coefficient, length, and beam-draft ratio of the parent. In order to cover the range of trawler displacement-length ratios, a maximum value of 500 and a minimum of 200 were selected. The displacement-length ratios selected were 500, 400, and 200. These, including the parent form of 300 displacement-length ratio, provided a uniform series for study at constant prismatic coefficient. Another reason for the selection of 200 as the minimum value was that this figure corresponded to the upper limit of the Taylor Standard Series as reanalyzed by Gertler (5).

This thesis consists of the development and testing of three models which embody these changes in displacement-length ratio. The model test results are expanded to the 100 foot ship and compared as a series as well as with individual ships of similar displacement-

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[1]Numbers in parentheses refer to references listed in the Bibliography.

length ratio and prismatic coefficient.

The 200, 400, and 500 displacement-length models will hereinafter be referred to as W-10, W-11, and W-12 respectively.

DESIGN

The design of the three models required the expansion of the lines of W-8 in a manner such that the displacement -length ratio varied, while the beam-draft ratio and prismatic coefficient remained the same. This was effected by varying the beam and draft of W-8 by a given factor and maintaining the model length of four feet between perpendiculars. The required factor was determined to be the square root of the ratio of the displacement-length ratio of the new model to that of W-8, i.e. $\sqrt{200/300} = .8165$, $\sqrt{400/300} = 1.155$, and $\sqrt{500/300} = 1.291$, for models W-10, W-11, and W-12 respectively.

The offsets of W-8 were taken from the lines drawing (4) and are included in the Appendix as Table I. The above factors were multiplied by these offsets to give tables of offsets of models W-10, W-11, and W-12. These tables are included in the Appendix as Tables IIA, IIB, and IIC. From the offsets, the lines drawings of the three new models were constructed and are included in the jacket of the back cover.

A summary of characteristics of models W-10, W-11, and W-12 is also included in the Appendix as Table III.

CONSTRUCTION

All three models were constructed from lifts of clear sugar pine of approximately 1 3/4 inch thickness. Half-breadths were taken from the body plan and the waterlines were drawn on the appropriate lifts. The lifts were cut slightly oversize to insure that adequate material was available for final finishing of the model. Material was removed from the inside of all lifts except the bottom lift in order to lighten the weight of the model and permit space within the models for towing fittings and for ballasting. At the end of each lift, tongues of approximately three inches in length were left. These tongues were then bored and were used as an aid in alignment during the gluing process. The lifts were placed in appropriate order on top of one another and glued in a gluing press using Weldwood glue.

Templates were constructed of Herlock cardboard for all stations including half stations at the ends, as well as for bow and stern profiles. Centerlines and station locations were marked on the models. Edges of the lifts were cut away until a relatively fair surface was obtained; templates, with centerline and deck line marked thereon, were then used at appropriate stations and at the bow and stern to bring the model nearly to the desired shape. Special planes, gouges, files, and chisels were used during this phase of construction. With the models now slightly oversized, sandpaper of varying degrees of coarseness was used until the templates fitted accurately and until

a fair surface was obtained in between station locations. Visual sighting and battens were employed to assist in the fairing process.

Seven coats of varnish were used in finishing models W-10 and W-11, while five coats were applied to W-12. After the application of the first coat, conventional sandpaper was used to remove most of the varnish. After each subsequent coat, wet and dry sandpaper of increasing fineness was used until a highly smooth surface was obtained. Three coats of varnish were applied to the interior of the models as a seal against moisture.

Blocks were mounted on the decks of each of the models, two forward and two aft, to support the wire freeboard gages. These blocks were carefully sized so that the top surface of all four blocks was at the same height above the designed waterline. This permitted rapid removal of trim and heel for model testing.

Towing and accelerating strut brackets constructed of aluminum were installed on each of the models. Models W-11 and W-12 had 1/8 inch thick towing brackets; all other aluminum fittings were of 3/32 inch.

A special 1/8 inch towing bracket was mounted on models W-11 and W-12 for high speed runs. An additional bracket was installed in the bottom of each model beneath the deck accelerating strut bracket. The purpose of these special fittings is described under Model Testing Procedure.

After completion of bare-hull resistance tests, pins were installed on the hulls forward to provide turbulence stimulation. The method of installation is described under Turbulence Stimulation.

MODEL TESTING PROCEDURE

Each of the models was tested under three separate conditions: 1) bare hull, 2) with a specified number of turbulence stimulating pins, and 3) with approximately twice the original number of pins. The reasons for these separate runs are fully described under Turbulence Stimulation.

The models were towed at their respective design displacements in fresh water of 80° F. All testing was performed with zero heel and trim. The length of the towing run was 35 feet. The towing point was located approximately 2 3/4 inches above the tank water level.

For all testing of model W-10, the small dynomometer was used. For the testing of models W-11 and W-12, the small dynomometer was used up to speeds in the vicinity of 3.5 to 4.0 feet per second. In all testing with the small dynomometer, the heavy spring at the upper position was used for pan weights greater than one half pound and the light spring at the lower position was used for pan weights less than one half pound. Testing the two larger models at high speeds with the small dynomometer was found to be impracticable due to the fact that a constant towing force was seldom attained. For speeds in excess of about 3.8 feet per second, a newly constructed large dynomometer of heavy construction, employing a water-filled dashpot, was used. The results were satisfactory, enabling the calculation of resistance values at speeds up to 5.1 feet per second, corresponding to a maximum pan weight of 3.975 pounds for model W-12. For use with this dynomometer, both models W-11 and W-12 were fitted with the special

towing bracket referred to in the section on Construction.

Longitudinal travel of the models was limited by the standard accelerating strut bracket mounted on the deck of the model slightly aft of station 5. An additional slotted bracket was mounted directly below the accelerating strut bracket. A roller bearing attached to the bottom of the accelerating strut fitted in this slot to prevent transverse motion of the models in the event of directional instability.

TURBULENCE STIMULATION

Results of bare hull testing of earlier trawler models at Webb indicated that laminar flow could be expected over a large speed range in models of high displacement-length ratio with vee-shaped sections forward and a large entrance angle. It was obvious that models W-11 and W-12, with displacement-length ratios of 400 and 500 respectively, and with relatively large entrance angles of 24.5° and 26°, would produce laminar flow. Model W-10, with a displacement-length ratio of 200 and an entrance angle of 18°, appeared less likely to give trouble from laminar flow, and, as bare hull tests of this model revealed, laminar flow existed over a much shorter range than for the other models. See Figures 1A, 1B, and 1C, Results of Testing.

In accordance with the recommended testing procedure of Professor C. R. Nevitt (6), which procedure was based in part on a series of turbulence stimulation tests carried out by Messrs. Franklin and Schwendtner (7), the following steps were taken to insure satisfactory turbulence stimulation:

1) A water temperature of 80° F. was maintained in the model tank.
2) A time interval of two minutes between runs was used for tests, except for the two larger models in the high speed range. At high speeds for these models, a 2 1/2 minute interval was selected as the shortest time in which to allow waves in the tank to be damped out. During slow speed tests, alternate high and low speed runs were carried out.

3) Turbulence was induced by mounting turbulence stimulators at the bows. The stimulators, fabricated from brass round stock were 0.125 inches in diameter and 0.035 inches in length, and were drilled to receive pins for mounting on the models. To locate the stimulators, or pins, on a model, a tangent was constructed to the stem profile at the design waterline. The pins were placed on a line constructed parallel to this tangent at a distance of 4 inches from it, measured along the design waterline. The line of pins extended from the design waterline to the keel, on both sides of the model.

It was necessary to establish some means of determining when sufficient stimulation had been produced to eliminate the laminar flow condition over a satisfactory range of speeds for all models. Each model first was tested with no stimulators attached. It was then tested with pins widely spaced, which produced a curve of higher resistance values than for the bare hull condition. It was concluded from this that certainly much of the laminar flow surrounding the model had been eliminated. It has been suggested that the increased drag of the pins is compensated for by the decreased frictional resistance due to assumed laminar flow forward of the pins (6). Hence, the resistance curve thus obtained was representative of actual conditions provided that fully turbulent flow existed. In order to insure that such was the case, a third series of runs was conducted, this time with the pins more closely spaced. In every case the resulting

resistance curves coincided with those obtained with the pins spaced farther apart. Obviously, turbulent flow existed at both conditions of pin spacing. Despite the greater drag caused by the increased number of pins, the resistance remained constant, indicating that overstimulation had very likely decreased frictional resistance aft of the pins sufficiently to cancel out the pin drag (6).

Model W-12 was investigated first, up to a speed-length ratio of 1.2, in the bare condition. The model was then investigated with pins spaced at 1/2 inch, and finally through its entire speed range with pins spaced 1/4 inch apart.

The results obtained on model W-12 indicated that pin spacing could be increased somewhat on lower displacement-length ratio models. Hence the pins were spaced 3/4 inch apart on model W-10 for its first test with stimulation. This spacing was then reduced to 3/8 inch for the final runs.

Model W-11 was tested with the same pin spacings that were used on W-12.

Figures 1A, 1B, and 1C show comparisons between the results of tests performed with and without pins. In the case of model W-10, the bare hull resistance coincides with the resistance obtained with pins at a Froude number of 0.27 and above. From this result, it is seen that the bare hull becomes fully turbulent when this value of Froude number is reached. Models W-11 and W-12 both showed a definite difference between the bare hull resistance curve and that with pins added. The authors believe that this difference is due to laminar flow for

the bare hull throughout the speed range tested, and not due to increased drag caused by the pins.

It is believed that the curve of resistance with pins is reliable down to a Froude number of about 0.20. Above this number, the evidence indicates close to fully turbulent flow for all models. A closer scrutiny of the curves for W-10 and W-11 indicates that no serious laminar flow exists above a Froude number of 0.16 for the former and of 0.18 for the latter.

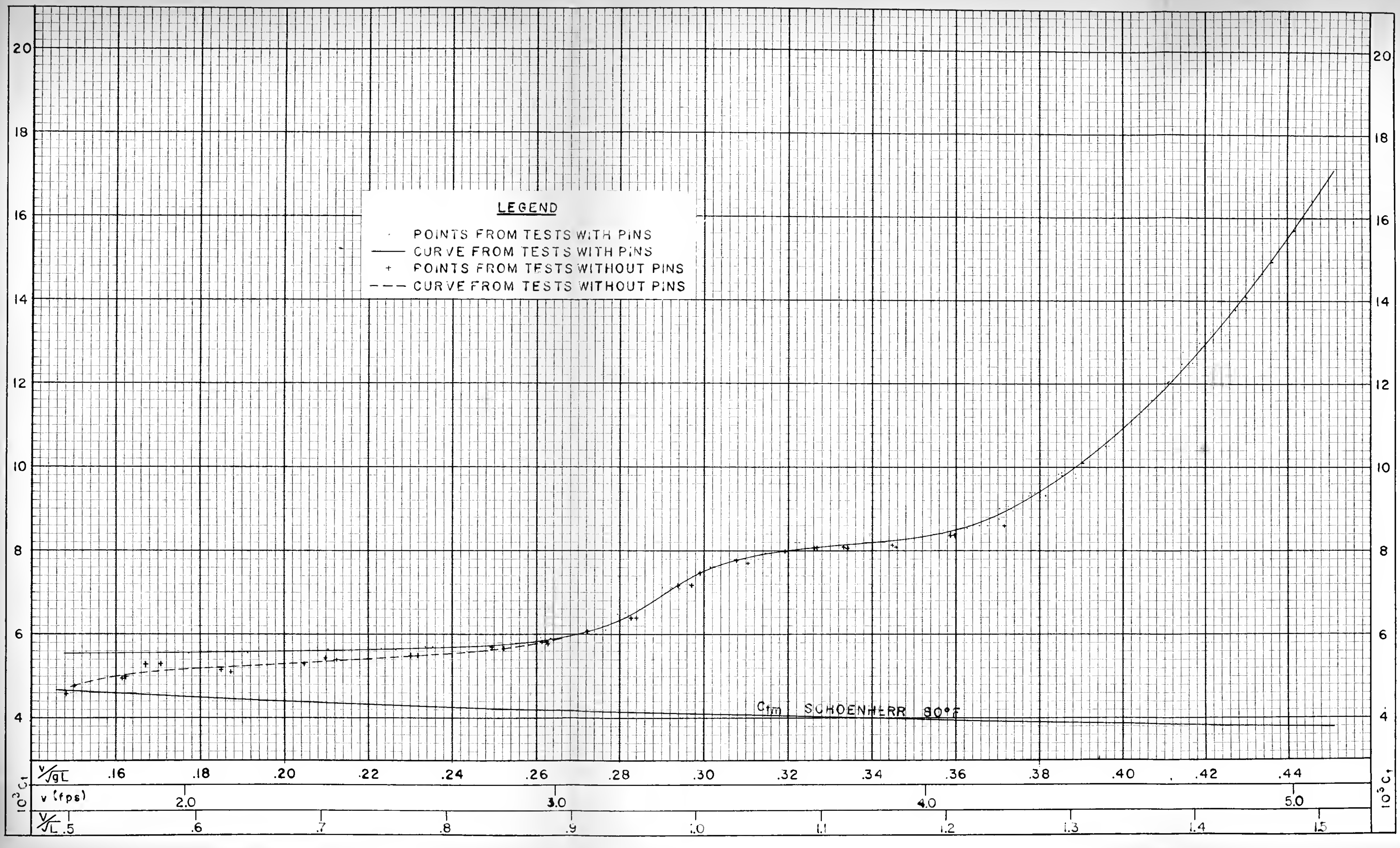
The resistance curves for all models are therefore considered quite reliable in the design speed range from a speed-length ratio of 0.7 to 1.5.

RESULTS OF TESTING

Valid points from tests of models W-10, W-11, and W-12 are shown in Figures 1A, 1B, and 1C respectively. Data is plotted on a scale of $C_{tm} \times 10^3$ versus Froude number. Speed scales in feet per second and $V/\sqrt{L}$ ratio are also included. The tabular calculations of C_{fm} and C_r also appear in these figures.

Figures 2A, 2B, and 2C are S.N.A.M.E. standard test report forms, showing the expansion of the test results of W-10, W-11, and W-12 to resistance and effective horsepower values for the one hundred foot ship. Much additional data on the models is also included on these forms.

Approximately two hundred points were taken for the resistance curves of each model. Repetition of points on different days was readily obtained. Results were generally consistent throughout the testing period.

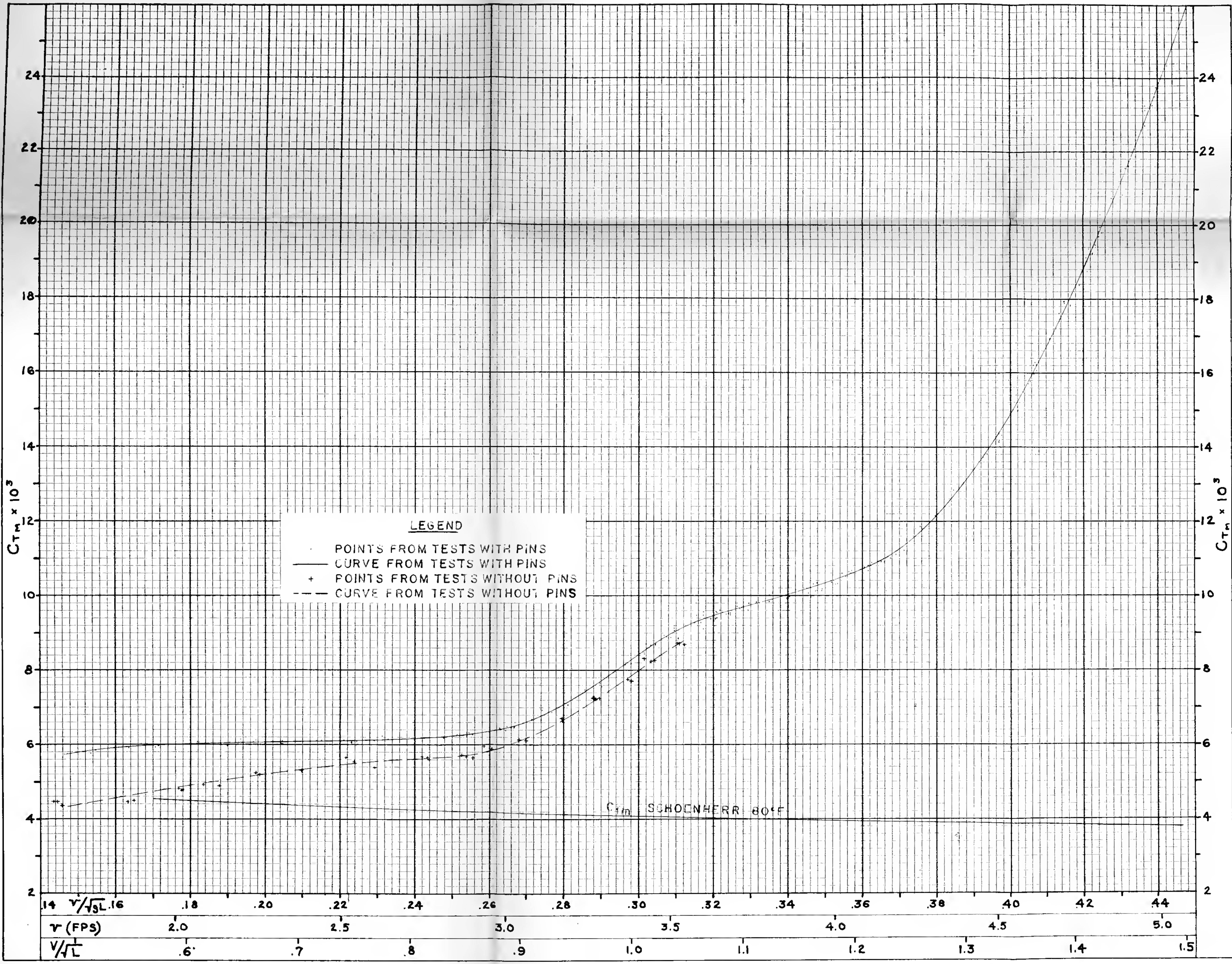


$\frac{V}{\sqrt{gL}}$	$R_n \times 10^{-6}$	$10^3 C_{tm}$	$10^3 C_{fm}$	$10^3 C_r$
.15	.7544	5.53	4.66	0.87
.16	.8046	5.55	4.60	0.95
.18	.9054	5.58	4.50	1.08
.20	1.006	5.60	4.41	1.19
.22	1.106	5.64	4.33	1.31
.24	1.207	5.70	4.25	1.45
.26	1.308	5.82	4.19	1.63
.28	1.408	6.33	4.13	2.20
.30	1.509	7.51	4.08	3.43
.32	1.609	8.01	4.03	3.98
.34	1.710	8.20	3.99	4.21
.36	1.811	8.50	3.94	4.56
.38	1.911	9.42	3.91	5.51
.40	2.012	10.92	3.87	7.05
.42	2.112	12.93	3.83	9.10
.44	2.213	15.50	3.80	11.70
.45	2.263	16.95	3.73	13.17

RESULTS OF TESTING
W-10

21-25 APRIL 1956
WATER TEMPERATURE 80°F

FIGURE 1-A



$v/\sqrt{gL}$	$R_E \times 10^6$	$C_{fm} \times 10^3$	$C_{TM} \times 10^3$	$C_R \times 10^3$
.16	.8052	4.60		
.18	.9058	4.49	6.02	1.53
.20	1.006	4.41	6.05	1.64
.22	1.107	4.33	6.09	1.76
.24	1.208	4.25	6.16	1.91
.26	1.308	4.19	6.85	2.16
.28	1.409	4.13	7.08	2.95
.30	1.510	4.08	8.42	4.34
.32	1.610	4.03	9.47	5.44
.34	1.711	3.99	10.03	6.04
.36	1.812	3.94	10.71	6.77
.38	1.912	3.91	12.17	8.26
.40	2.013	3.87	14.89	11.02
.42	2.114	3.83	18.84	15.01
.44	2.214	3.80	23.8	20.00

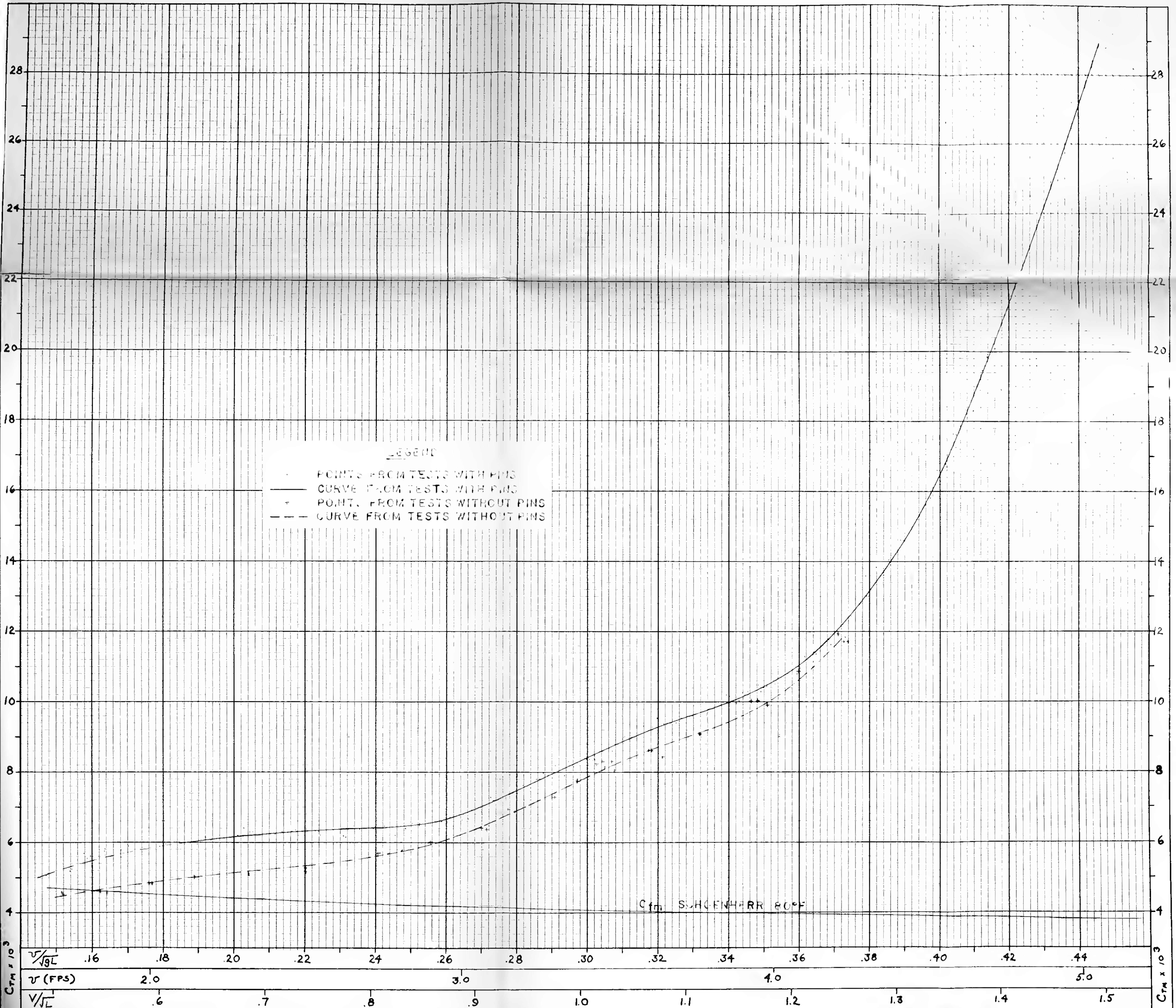
RESULTS OF TESTING

W-11

5-21 MAY 1956

WATER TEMPERATURE 80°F

FIGURE 1-B



$V/\sqrt{gL}$	$R_E \times 10^6$	$C_{fm} \times 10^3$	$C_{TM} \times 10^3$	$C_R \times 10^3$
15	7544	4.66		
[illegible]	8048	4.60		
18	[illegible]54	4.50		
.20	1.006	[illegible]	6.16	1.75
.22	1.106	4.33	6.33	[illegible]
24	1.207	4.25	6.40	2.15
.26	1.308	4.19	6.67	2.48
.28	1.408	4.13	7.48	3.35
.30	1.509	4.08	8.43	4.35
.32	1.609	4.03	9.29	5.26
.34	1.710	3.99	9.98	5.99
.36	1.811	3.94	11.06	7.12
.38	1.911	3.91	13.17	9.26
.40	2.012	3.87	16.48	12.61
42	2.112	3.83	21.35	17.52
.44	2.213	3.80	27.13	23.33

RESULTS OF TESTING
W-12

14-30 APRIL 1958
WATER TEMPERATURE 80°F

FIGURE I-C

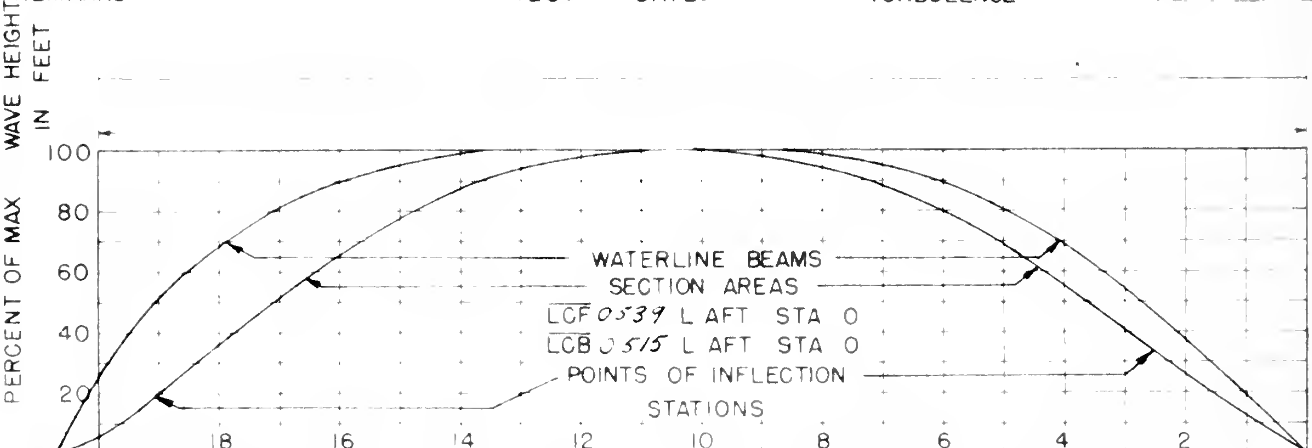
W - 10

S.N.A & M.E

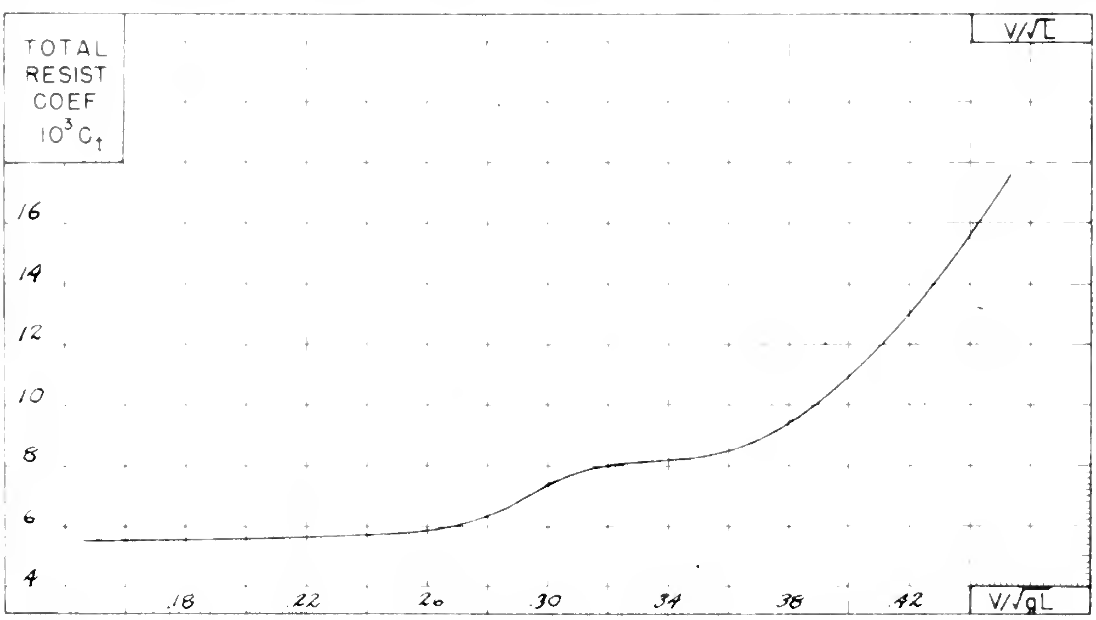
MODEL RESISTANCE DATA

SHEET

SHIP *WEBB STANDARD SERIES TRAWLER MODEL W 10* | LABORATORY *RMB* | WATER TEMP. *80°F* λ *25*
BASIN | WATER COND. *STILL, FR* $\lambda^{1/2}$ *5*
MODEL NO *W 10* | BASIN SIZE *93.0×10.0×5.0* | MODEL MATERIAL *WOOD* λ^2 *625*
APPENDAGES *NONE* | MODEL LENGTH *4.00* | MODEL FINISH *VARNISH* λ^3 *15625*
REMARKS | TEST DATE | TURBULENCE



A/A_X	.039	197	362	.516	.658	.870	.973	1000	.945	.800	.558	.414	.265	.120	.000
B/B_X	.270	.523	.702	.817	.902	.985	1000	1000	.987	.902	.685	.534	.368	.189	.000
$\overline{BD}/\overline{BD}$	.155	.325	.446	.546	.626	.766	.845	.867	.842	.749	.575	.457	.319	.172	.000
dA/dL	2.50	3.46	3.19	2.99	2.69	1.60	0.60	0.00	1.04	1.43	2.73	2.96	3.06	2.71	1.97



f_E 0.00
f_R 0.039
t_E 0.90
t_R 1.21
i_E 18.0°
i_R 47.0°

L 4.00 FT
B_X .7211 FT.
H_X .314 FT
TRIM 0.00 FT
D 27.87 LBS FW.
Δ 0.0128 TONS SW.
∇ .448 FT^3
S 3.546 FT^2
OBL. CORR
A_X 0.172 FT^2
A_W 2.24 FT^2

ρ 1.9336 LBS. SEC^2/FT^4
ν 0.92969 $\times 10^{-5} FT^2/SEC.$

V_{kts}	R_t	10^3C_t	$V/\sqrt{gL}$	$R_n \times 10^{-6}$	V_{kts}	R_t	10^3C_t	$V/\sqrt{gL}$	$R_n \times 10^{-6}$	V_{kts}	R_t	10^3C_t	$V/\sqrt{gL}$	$R_n \times 10^{-6}$
		5.53	.15	.7544			9.42	.38	1.911					
		5.55	.16	.8048			10.92	.40	2.012					
		5.58	.18	.9054			12.93	.42	2.112					
		5.60	.20	1.006			15.50	.44	2.213					
		5.64	.22	1.106			16.95	.45	2.263					
		5.70	.24	1.207										
		5.82	.26	1.308										
		6.33	.28	1.408										
		7.51	.30	1.509										
		8.01	.32	1.609										
		8.20	.34	1.710										
		8.50	.36	1.811										

BASED ON L_{WL}

L_{WL} 4.125' L_{BP}/L_{WL} .970
$\Delta/(0.010L)^3$ 182.3
$\nabla/(0.10L)^3$ 6.38
L/B_X 5.72 $L/\nabla^{1/3}$ 5.39
C_B .480 C_P .631 C_W .752
$\overline{LCF}$ .522 L_{WL} AFT STA. 0
$\overline{LCB}$ .500 L_{WL} AFT STA 0
$S/\sqrt{\Delta}$ 15.45

FIGURE 2-A-1

W - 10

RATIOS AND COEFFICIENTS

L/B_X	5.55	C_P	.650	C_W	.775	A_X/A_M	1.00	B_{IX}/B_X	1.00
B_X/H_X	2.29	C_X	.760	C_{PV}	.634	B_X/B_M	1.00	B_{WX}/B_X	1.00
$\Delta/(0.010L)^3$	200	C_{PF}	.617	C_{PA}	.682	H_X/H_M	1.00	C_{IT}	.612
$\nabla/(0.10L)^3$	7.00	C_{WF}	.695	C_{WA}	.854	$\overline{BKW}/B_X$	None	C_{IL}	.592
$L/\nabla^{1/3}$	5.23	C_{PVF}	.674	C_{PVA}	.606	$\overline{BR}/B_X$	None	T_q	-
$S/\nabla^{2/3}$	6.06	C_{PE}	.617	C_{PR}	.682	$\overline{DR}/B_X$	.182		
$S/\sqrt{\Delta L}$	15.65	C_{WE}	.695	C_{WR}	.854	$\overline{HS}/B_X$	.125		
C_B	.494	C_{PVE}	.674	C_{PVR}	.606	$\overline{KB}/H_M$	-		

EXPANDED RESISTANCE DATA

DIMENSIONS FOR 100 FT. LENGTH

L	100.00 FT.	Δ	200 TONS S.W.	T	59 °F	FRICTION BASIS	
B_X	18.03 FT.	∇	6995 FT^3	ρ	1.9905 LBS SEC^2/FT^4	SCHOENHERR - SCHOENHERR	
H_X	7.86 FT.	S	2216 FT^2	ν	1.2817×10^{-5} FT^2/SEC	ROUGHNESS ALLOWANCE	0.4
TRIM	0.00 FT.	REMARKS					

$V/\sqrt{gL}$	.16	.18	.20	.22	.24	.26	.28	.29	.30	.31
$V/\sqrt{L}$	.537	.604	.672	.739	.806	.873	.940	.974	1.007	1.040
Ⓚ	1.296	1.458	1.622	1.784	1.946	2.107	2.269	2.351	2.431	2.510
V	5.37	6.04	6.72	7.39	8.06	8.73	9.40	9.74	10.07	10.40
$10^{-6} R_n$	72.9	82.0	91.2	100.3	109.5	118.5	127.6	132.3	136.7	141.1
$10^3 C_f$	2.17	2.13	2.10	2.07	2.05	2.02	2.00	1.99	1.98	1.98
$10^3 C_r$	0.95	1.08	1.19	1.31	1.45	1.63	2.20	2.91	3.43	3.78
$10^3 \Delta C_f$	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
$10^3 C_t$	3.52	3.61	3.69	3.78	3.90	4.05	4.60	5.30	5.81	6.16
$10^3 C_t\ S/\nabla^{2/3}$	21.33	21.88	22.36	22.91	23.63	24.54	27.88	32.12	35.21	37.33
Ⓒ 100	.847	.870	.889	.910	.939	.975	1.108	1.276	1.400	1.483
R	638	827	1048	1297	1595	1940	2556	3160	3700	4190
R/Δ	3.19	4.14	5.24	6.48	7.98	9.70	12.78	15.80	18.50	20.95
EHP	10.5	15.4	22	30	40	52	74	95	114	134
TAYLOR EHP	[illegible]	13.2	18	25	34	48	80			
EHP/TAYLOR EHP	1.12	1.17	1.22	1.20	1.18	1.08	.925			

$V/\sqrt{gL}$	.32	.33	.34	.35	.36	.38	.40	.42	.44	.45
$V/\sqrt{L}$	1.074	1.108	1.141	1.175	1.209	1.276	1.343	1.410	1.477	1.510
Ⓚ	2.593	2.675	2.754	2.836	2.918	3.080	3.242	3.404	3.565	3.645
V	10.74	11.08	11.41	11.75	12.09	12.76	13.43	14.10	14.77	15.10
$10^{-6} R_n$	145.9	150.4	155.0	159.5	164.1	173.2	182.4	191.4	200.5	205.0
$10^3 C_f$	1.97	1.96	1.95	1.94	1.94	1.92	1.91	1.90	1.88	1.88
$10^3 C_r$	3.98	4.10	4.21	4.34	4.56	5.51	7.05	9.10	11.70	13.17
$10^3 \Delta C_f$	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
$10^3 C_t$	6.35	6.46	6.56	6.68	6.90	7.83	9.36	11.40	13.98	15.45
$10^3 C_t\ S/\nabla^{2/3}$	38.48	39.15	39.75	40.48	41.81	47.50	56.72	69.15	84.64	93.60
Ⓒ 100	1.529	1.556	1.580	1.609	1.661	1.885	2.255	2.744	3.364	3.720
R	4600	4975	5370	5790	6340	8010	10610	14250	19140	22160
R/Δ	23.00	24.88	26.85	28.95	31.70	40.05	53.05	71.25	95.70	110.80
EHP	152	170	188	209	236	314	438	618	869	1029
TAYLOR EHP										
EHP/TAYLOR EHP										

FIGURE 2-A-2

W - 10

EXPANDED RESISTANCE CURVES

FOR 100 FOOT LENGTH

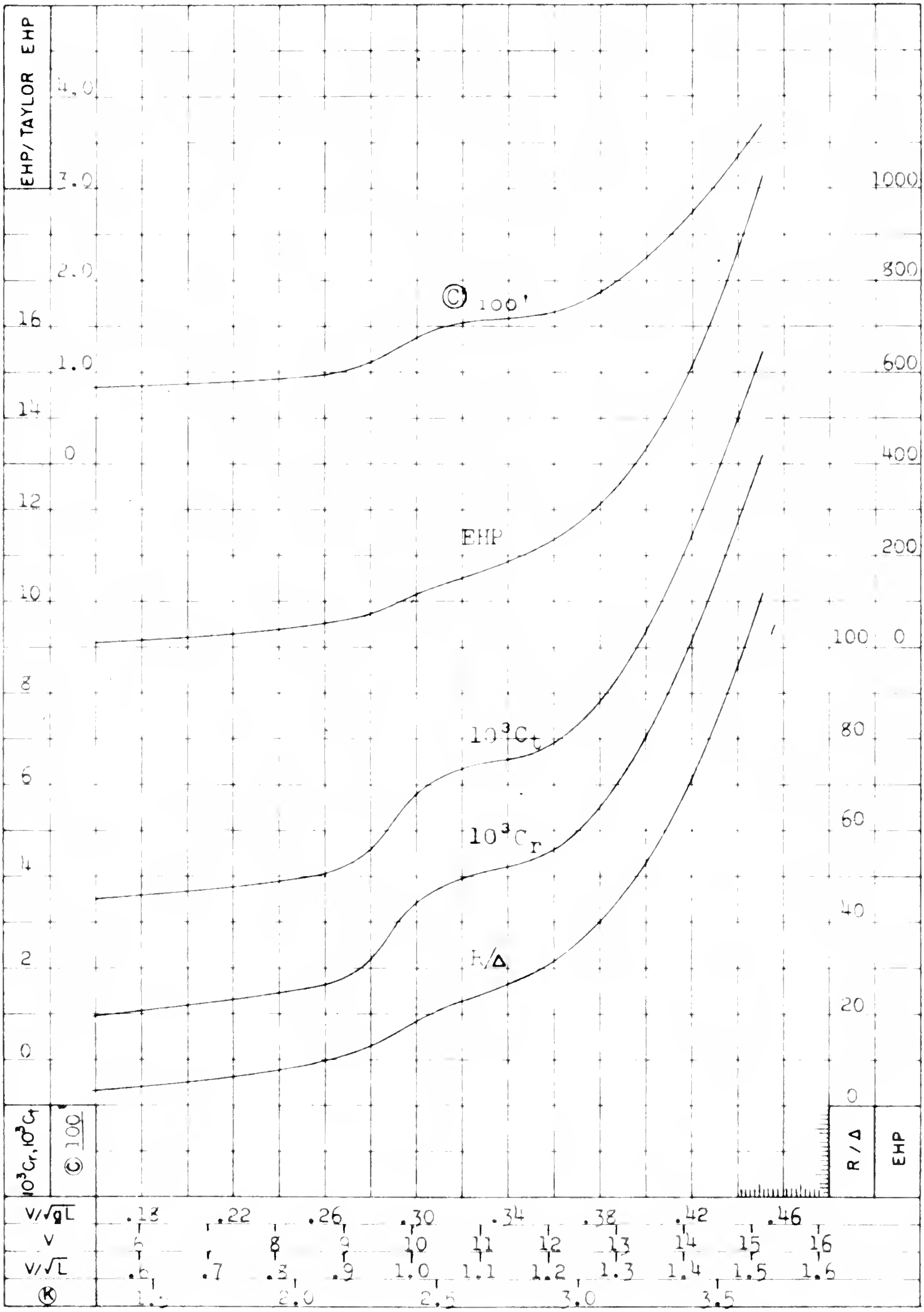


FIGURE 2-A-3

S.N.A. & M.E.

W - 11

MODEL RESISTANCE DATA

SHEET

SHIP Webb Standard Series

LABORATORY RMB

WATER TEMP 80° F λ 25

BASIN

WATER COND Still, Fresh $\lambda^{1/2}$ 5

MODEL NO W - 11

BASIN SIZE 93.0' × 10.0' × 5.0'

MODEL MATERIAL Wood λ^2 625

APPENDAGES None

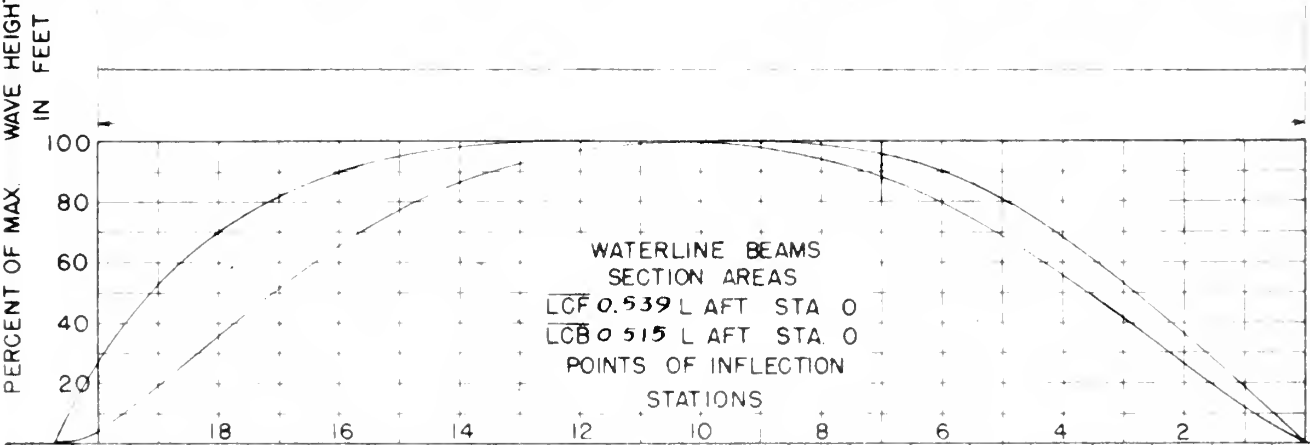
MODEL LENGTH 4.00'

MODEL FINISH Varnish λ^3 15625

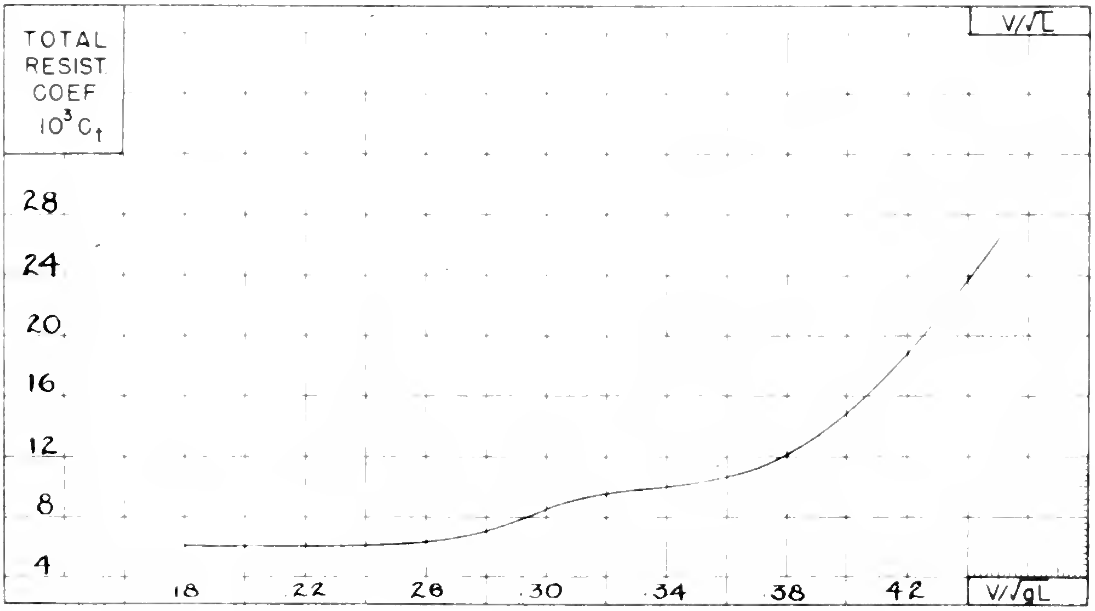
REMARKS

TEST DATE 5-21 May '56

TURBULENCE 45 Pins ¼" Spacing



			18		16	14	12	10	8	6	4		2		
A/Ax	.039	.197	.362	.516	658	.870	.973	1.000	.945	.800	.558	.414	.265	.120	.000
B/Bx	.270	.523	.702	817	.902	.985	1000	1.000	987	902	.685	534	.368	.189	.000
$\overline{BD}/\overline{BD}$	.155	.325	.446	546	.628	.766	.845	867	842	.749	.575	.457	.319	172	.000
dA/dL	2.50	3.48	3.19	2.99	2.69	1.60	0.60	0.00	1.04	1.93	2.73	2.96	3.06	2.71	1.97



f_E 0.00
f_R 0.039
t_E 0.90
t_R 1.21
i_E 24.5°
i_R 58.5°

L 4.00 FT
B_X 1.020 FT.
H_X .4448 FT
TRIM 0.00 FT
D 55.73 LBS. FW
Δ .0256 TONS SW.
∇ .8954 FT^3
S 5.016 FT^2
OBL. CORR. No
A_X .345 FT^2
A_W 3.178 FT^2

ρ 1.9336 LBS. SEC^2/FT^4
ν 0.92969 $\times 10^{-5} FT^2/SEC.$

V_{kts}	R_t	$10^3 C_t$	$V/\sqrt{gL}$	$R_n \times 10^{-6}$	V_{kts}	R_t	$10^3 C_t$	$V/\sqrt{gL}$	$R_n \times 10^{-6}$	V_{kts}	R_t	$10^3 C_t$	$V/\sqrt{gL}$	$R_n \times 10^{-6}$
		6.02	.18	.9058			18.84	.42	2.114					
		6.05	.20	1.006			23.80	.44	2.214					
		6.09	.22	1.107										
		6.16	.24	1.208										
		6.35	.26	1.308										
		7.08	.28	1.409										
		8.42	.30	1.510										
		9.47	.32	1.610										
		10.03	.34	1.711										
		10.71	.36	1.812										
		12.17	.38	1.912										
		14.89	.40	2.013										

BASED ON L_{WL}

L_{WL} 4.125 L_{BP}/L_{WL} 0.970
$\Delta/(0.010L)^3$ 364.7
$\nabla/(0.10L)^3$ 12.76
L/B_X 4.044 $L/\nabla^{1/3}$ 4.28
C_B .480 C_P .631 C_W .752
$\overline{LCF}$ .522 L_{WL} AFT STA. 0
$\overline{LCB}$ .500 L_{WL} AFT STA. 0
$S/\sqrt{\Delta L}$ 15.43

FIGURE 2-B-1

W - 11

RATIOS AND COEFFICIENTS

L/B_X	3.92	C_P	.650	C_W	.779	A_X/A_M	1.00	B_{IX}/B_X	1.00
B_X/H_X	2.29	C_X	.760	C_{PV}	.634	B_X/B_M	1.00	B_{WX}/B_X	1.00
$\Delta/(0.010L)^3$	400	C_{PF}	.617	C_{PA}	.682	H_X/H_M	1.00	C_{IT}	.612
$\nabla/(0.10L)^3$	13.99	C_{WF}	.695	C_{WA}	.854	$\overline{BKW}/B_X$	None	C_{IL}	.592
$L/\nabla^{1/3}$	4.15	C_{PVF}	.674	C_{PVA}	.606	$\overline{BR}/B_X$	None	T_q	—
$S/\nabla^{2/3}$	5.40	C_{PE}	.617	C_{PR}	.682	$\overline{DR}/B_X$	.182		
$S/\sqrt{\Delta L}$	15.68	C_{WE}	.695	C_{WR}	.854	$\overline{HS}/B_X$	.125		
C_B	.494	C_{PVE}	.674	C_{PVR}	.606	$\overline{KB}/H_M$	—		

EXPANDED RESISTANCE DATA

DIMENSIONS FOR 100 FT. LENGTH

L 100.00 FT. Δ 400 TONS S.W. T 59 °F FRICTION BASIS

B_X 25.51 FT. ∇ 13991 FT^3 ρ 1.9905 LBS SEC^2/FT^4 SCHOENHERR - SCHOENHERR

H_X 11.12 FT. S 3135 FT^2 ν 1.2817×10^{-5} FT^2/SEC ROUGHNESS ALLOWANCE 0.4

TRIM 0.00 FT. REMARKS

$V/\sqrt{gL}$	.18	.20	.22	.24	.26	.28	.30	.32	.34	.36
$V/\sqrt{L}$	.604	.672	.739	.806	.873	.940	1.007	1.074	1.141	1.209
Ⓚ	1.298	1.444	1.588	1.732	1.876	2.020	2.164	2.308	2.452	2.599
V	6.04	6.72	7.39	8.06	8.73	9.40	10.07	10.74	11.41	12.09
$10^{-6}R_n$	82.0	91.2	100.3	109.5	118.5	127.6	136.7	145.9	155.0	164.1
$10^3 C_f$	2.13	2.10	2.07	2.05	2.02	2.00	1.98	1.97	1.95	1.94
$10^3 C_r$	1.53	1.64	1.76	1.91	2.16	2.95	4.34	5.44	6.04	6.77
$10^3 \Delta C_f$	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
$10^3 C_t$	4.06	4.14	4.23	4.36	4.58	5.35	6.72	7.81	8.39	9.11
$10^3 C_t\ S/\nabla^{2/3}$	21.92	22.35	22.84	23.54	24.73	28.88	36.28	42.17	45.30	49.18
Ⓒ 100'	.872	.889	.909	.937	.984	1.149	1.444	1.678	1.802	1.957
R	1320	1661	2082	2520	3105	4209	6067	8027	9731	11852
R/Δ	3.30	4.15	5.40	6.30	7.76	10.52	15.17	20.07	24.33	29.63
EHP	24.51	34.25	47.24	62.35	83.21	121.53	187.64	264.90	341.10	440.03
TAYLOR EHP										
EHP/TAYLOR EHP										

$V/\sqrt{gL}$	.38	.40	.42	.44						
$V/\sqrt{L}$	1.276	1.343	1.410	1.477						
Ⓚ	2.743	2.887	3.031	3.175						
V	12.76	13.43	14.10	14.77						
$10^{-6}R_n$	173.2	182.4	191.4	200.5						
$10^3 C_f$	1.92	1.91	1.90	1.88						
$10^3 C_r$	8.26	11.02	15.01	20.00						
$10^3 \Delta C_f$	0.40	0.40	0.40	0.40						
$10^3 C_t$	10.58	13.33	17.31	22.28						
$10^3 C_t\ S/\nabla^{2/3}$	57.12	71.97	93.46	120.29						
Ⓒ 100'	2.273	2.864	3.719	4.786						
R	15530	21393	30644	43274						
R/Δ	38.82	53.48	76.61	108.18						
EHP	600.66	882.18	1327.2	1963.1						
TAYLOR EHP										
EHP/TAYLOR EHP										

FIGURE 2-B-2

X - 11

EXPANDED RESISTANCE CURVES

FOR 100 FOOT LENGTH

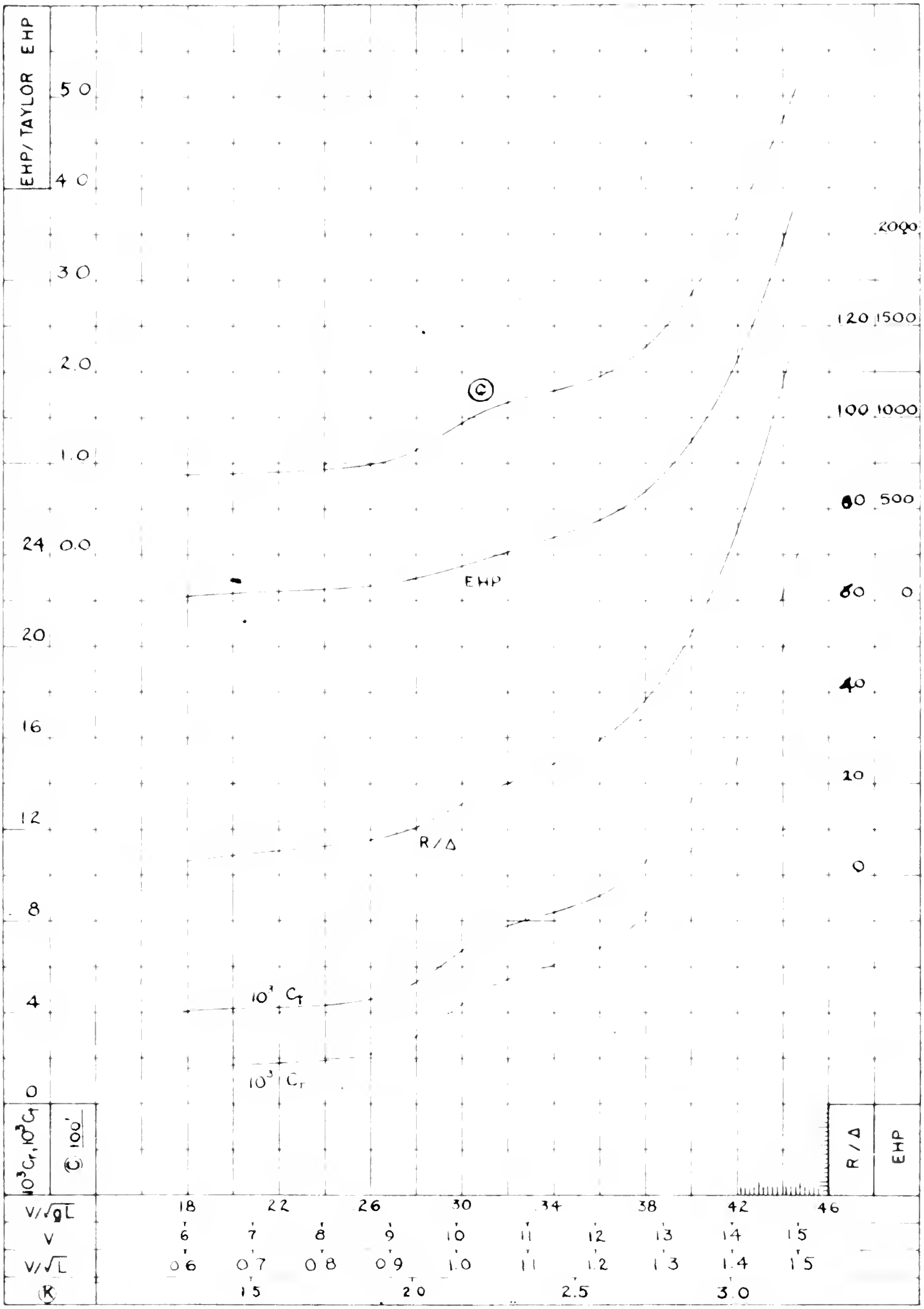
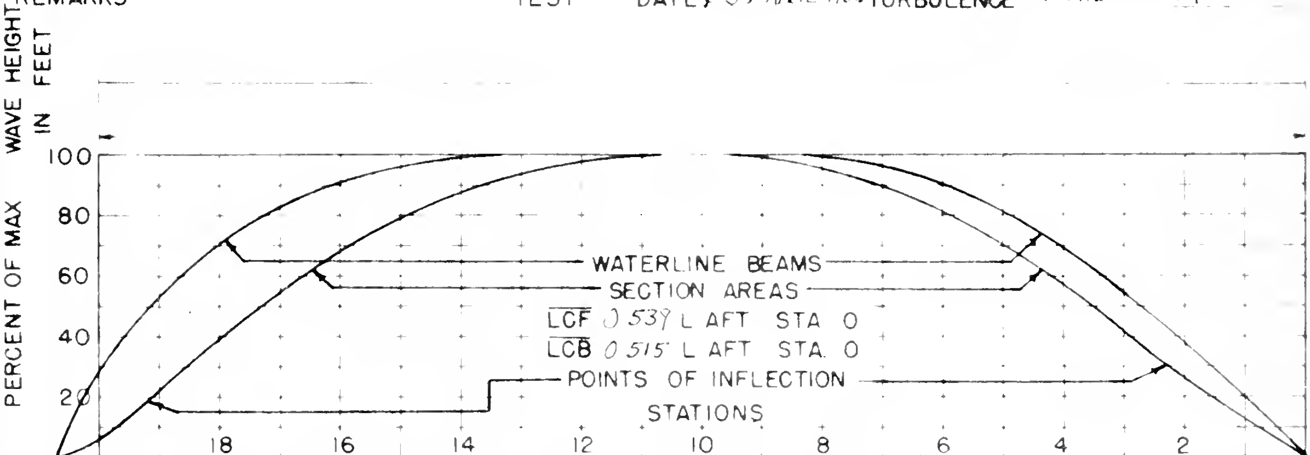


FIGURE 2-B-3

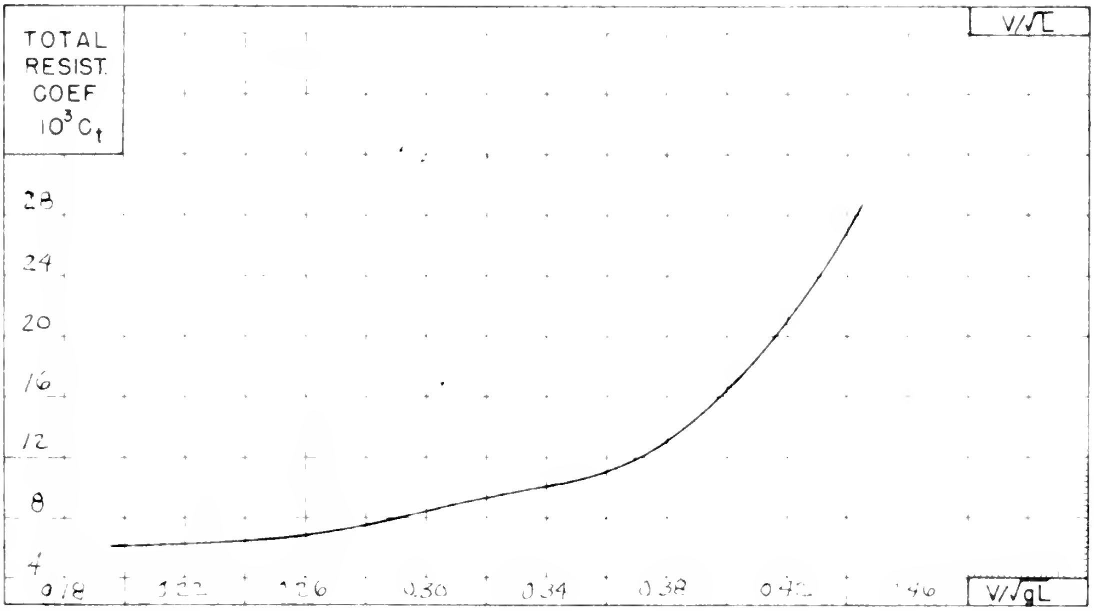
W - 12

S.N.A & M.E. | MODEL RESISTANCE DATA | SHEET

SHIP WEBB STANDARD SERIES TRAWLER MODEL W-12	LABORATORY RMB	WATER TEMP 80°F — λ 25
	BASIN	WATER COND STILL, FRESH — $\lambda^{1/2}$ 5
MODEL NO W-12	BASIN SIZE 930'x10.0'x5.0'	MODEL MATERIAL WOOD — λ^2 625
APPENDAGES NONE	MODEL LENGTH 4.00'	MODEL FINISH VARNISH — λ^3 15625
REMARKS	TEST DATE 13, 16, 18, 27, 30 APRIL 1956	TURBULENCE 51 PINS — 1/4" SPACING



A/A_X	039	197	362	516	658	870	973	1000	945	800	558	414	265	120	.000
B/B_X	270	.523	702.	817	902	985	1000	1000	987	902	685	534	368	189	000
$\overline{BD}/\overline{BDi}$	155	325	446	546	628	766	845	867	842	749	.515	457	319	.172	.000
dA/dL	250	348	319	299	269	160	0.30	000	104	193	273	296	306	271	197



f_E	0.00
f_R	0.039
t_E	0.90
t_R	1.21
i_E	26.0°
i_R	60.0°

L	4.00	FT
B_X	1.140	FT
H_X	0.496	FT
TRIM	0.00	FT
D	69.67	LBS FW
Δ	.0320	TONS S.W.
∇	1.119	FT^3
S	5.59	FT^2
OBL CORR.	No	
A_X	0.430	FT^2
A_W	3.55	FT^2

V_{kts}	R_t	10^3C_t	$V/\sqrt{gL}$	$R_n \times 10^{-6}$	V_{kts}	R_t	10^3C_t	$V/\sqrt{gL}$	$R_n \times 10^{-6}$	V_{kts}	R_t	10^3C_t	$V/\sqrt{gL}$	$R_n \times 10^{-6}$
		6.16	.20	1.006			21.35	42	2.112					
		6.33	22	1.106			27.13	44	2.213					
		6.40	.24	1.207										
		6.67	26	1.308										
		7.48	28	1.408										
		8.43	30	1.509										
		9.29	.32	1.609										
		9.98	34	1.710										
		11.06	36	1.811										
		13.17	.38	1.911										
		16.48	40	2.012										

ρ 1.9336 LBS SEC^2/FT^4

ν 0.9269 $\times 10^{-5} FT^2/SEC.$

BASED ON L_{WL}

L_{WL}	4.125	L_{BP}/L_{WL}	0.970
$\Delta/(0.010L)^3$	453.1		
$\nabla/(0.10L)^3$	15.95		
L/B_X	3.62	$L/\nabla^{1/3}$	3.97
C_B	.480	C_P .631	C_W .752
$\overline{LCF}$	.522	L_{WL} AFT STA 0	
$\overline{LCB}$	.500	L_{WL} AFT STA 0	
$S/\sqrt{\Delta L}$	15.42		

FIGURE 2-C-1

W - 12

RATIOS AND COEFFICIENTS

L/B_X	3.51	C_P	.650	C_W	.779	A_X/A_M	1.000	B_{IX}/B_X	1.000
B_X/H_X	2.29	C_X	.760	C_{PV}	.634	B_X/B_M	1.000	B_{WX}/B_X	1.000
$\Delta/(0.010L)^3$	500	C_{PF}	.617	C_{PA}	.682	H_X/H_M	1.000	C_{IT}	.612
$\nabla/(0.10L)^3$	17.50	C_{WF}	.695	C_{WA}	.854	$\overline{BKW}/B_X$	None	C_{IL}	.592
$L/\nabla^{1/3}$	3.85	C_{PVF}	.674	C_{PVA}	.606	$\overline{BR}/B_X$	None	T_q	—
$S/\nabla^{2/3}$	5.18	C_{PE}	.617	C_{PR}	.682	$\overline{DR}/B_X$	.92		
$S/\sqrt{\Delta L}$	15.62	C_{WE}	.695	C_{WR}	.854	$\overline{HS}/B_X$	.25		
C_B	.494	C_{PVE}	.674	C_{PVR}	.606	$\overline{KB}/H_M$	—		

EXPANDED RESISTANCE DATA

DIMENSIONS FOR 100 FT LENGTH

L 100.00 FT Δ 500 TONS S W T 59 °F FRICTION BASIS

B_X 28.47 FT ∇ 17484 FT³ ρ 1.9905 LBS SEC²/FT⁴ SCHOENHERR - SCHOENHERR

H_X 12.42 FT S 3491 FT² ν 1.2817×10^{-5} FT²/SEC ROUGHNESS ALLOWANCE 0.4

TRIM 0.00 FT. REMARKS

$V/\sqrt{gL}$	20	22	24	26	28	30	32	34	36	38
$V/\sqrt{L}$	.672	.739	.806	.873	.940	1.007	1.074	1.142	1.209	1.276
(K)	1.392	1.530	1.670	1.810	1.950	2.086	2.226	2.363	2.504	2.641
V	6.72	7.37	8.06	8.73	9.40	10.07	10.74	11.42	12.09	12.76
$10^{-6}R_n$	91.2	100.5	109.5	118.5	127.6	136.7	145.9	155.0	164.1	173.2
$10^3 C_f$	2.10	2.07	2.05	2.02	2.00	1.98	1.97	1.95	1.94	1.92
$10^3 C_r$	1.75	2.00	2.15	2.48	3.35	4.35	5.26	5.99	7.12	9.26
$10^3 \Delta C_f$	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
$10^3 C_t$	4.25	4.47	4.60	4.90	5.75	6.73	7.65	8.34	9.46	11.58
$10^3 C_t\ S/\nabla^{2/3}$	21.95	23.08	23.76	25.30	29.69	34.76	39.40	43.07	48.85	59.80
(C) 100'	.813	.918	.945	1.007	1.181	1.383	1.568	1.714	1.944	2.379
R	1899	2450	2961	3699	5038	6766	8733	10770	13710	18680
R/Δ	3.80	4.90	5.92	7.40	10.08	13.53	17.47	21.54	27.42	37.36
EHP	39.3	54.1	73	99.2	145	209	288	378	509	732
TAYLOR EHP										
EHP/TAYLOR EHP										

$V/\sqrt{gL}$	40	42	44							
$V/\sqrt{L}$	1.343	1.410	1.477							
(K)	2.783	2.922	3.060							
V	13.43	14.10	14.77							
$10^{-6}R_n$	182.4	191.4	200.5							
$10^3 C_f$	1.91	1.90	1.88							
$10^3 C_r$	12.61	17.52	23.33							
$10^3 \Delta C_f$	0.40	0.40	0.40							
$10^3 C_t$	14.92	19.82	25.61							
$10^3 C_t\ S/\nabla^{2/3}$	77.05	102.35	132.26							
(C) 100'	3.066	4.073	5.262							
R	26670	39070	55390							
R/Δ	53.34	78.14	110.78							
EHP	1100	1691	2512							
TAYLOR EHP										
EHP/TAYLOR EHP										

FIGURE 2-C-2

W - 12

EXPANDED RESISTANCE CURVES

FOR 100 FOOT LENGTH

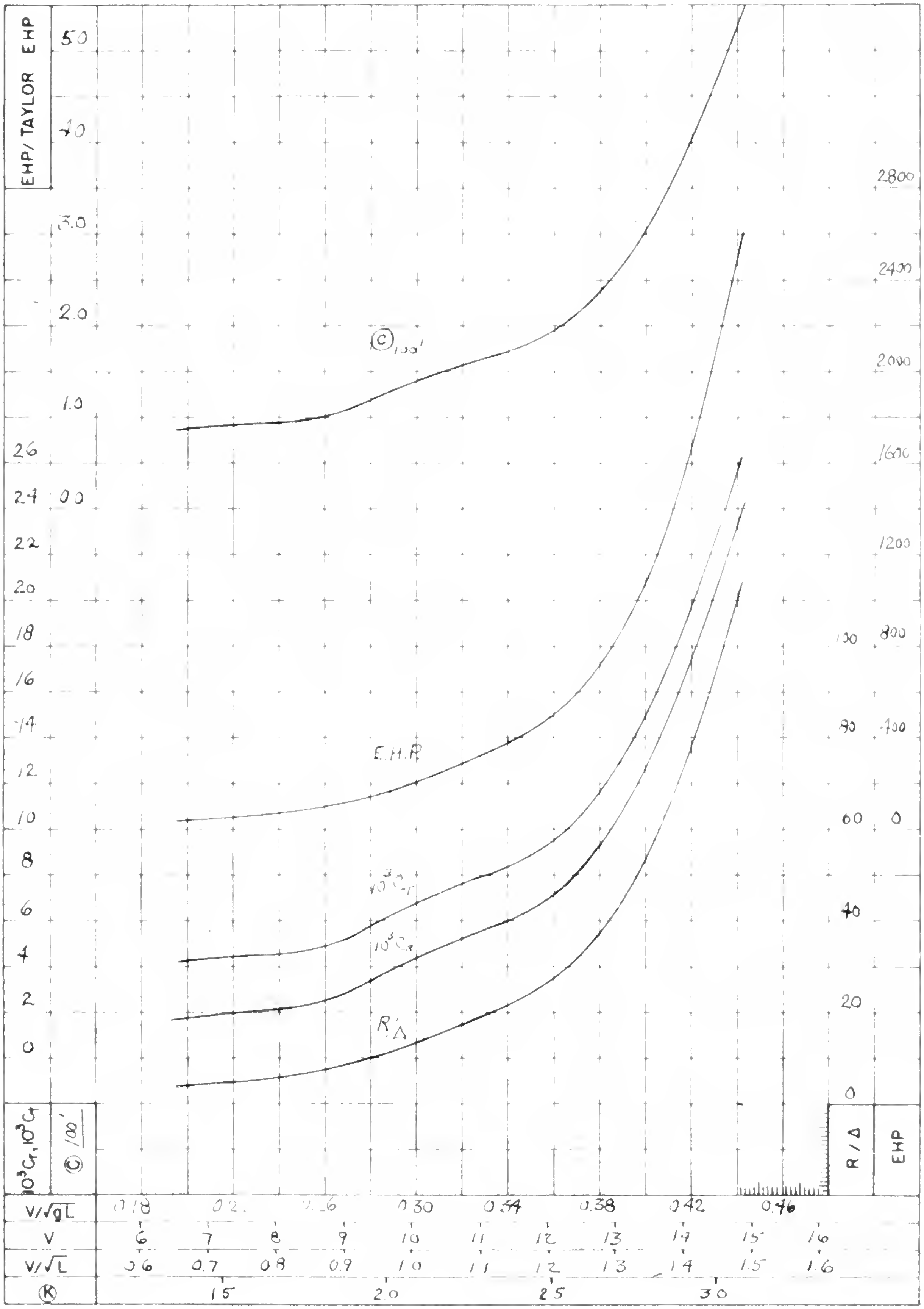


FIGURE 2-C-3

CONCLUSIONS

a) A Comparison of W-8, W-10, W-11, and W-12:

Figure 3 is a comparison of the four models of 0.65 prismatic coefficient expanded to one hundred feet. (C) is plotted against (K), as is the custom when comparing ships of different displacements. It is noted that the pattern of behavior of each of the lower three displacement-length vessels is quite similar. There is a definite hump and hollow in the resistance curve in the region of (K) equal to 2.2 to 2.8. These humps and hollows are caused by variations in the behavior of surface waves generated by the model itself, as is well known. Superposition of a bow wave crest and the stern wave hollow at the stern tends to cause hollows in the resistance curve, while humps are caused by low water level at the stern when a hollow from the bow wave system coincides with the stern wave hollow (12, 13, 14).

The interesting phenomenon here is the behavior of model W-12 as compared with that of the others. A plot of C_r versus $V/\sqrt{L}$ ratio, Figure 4, is included in order to eliminate the frictional resistance effects and better observe the wave-making properties of the four models. It is noted that the residual resistance curve of W-12 crosses that of W-11 in the vicinity of the design speed-length ratio of 1.1. The hump and the hollow have become much less pronounced for this model. The humps and hollows of the resistance curve tend to flatten as the models become fatter, but it is seen that this flattening is a gradual process until the W-12 curve is reached, when it becomes quite

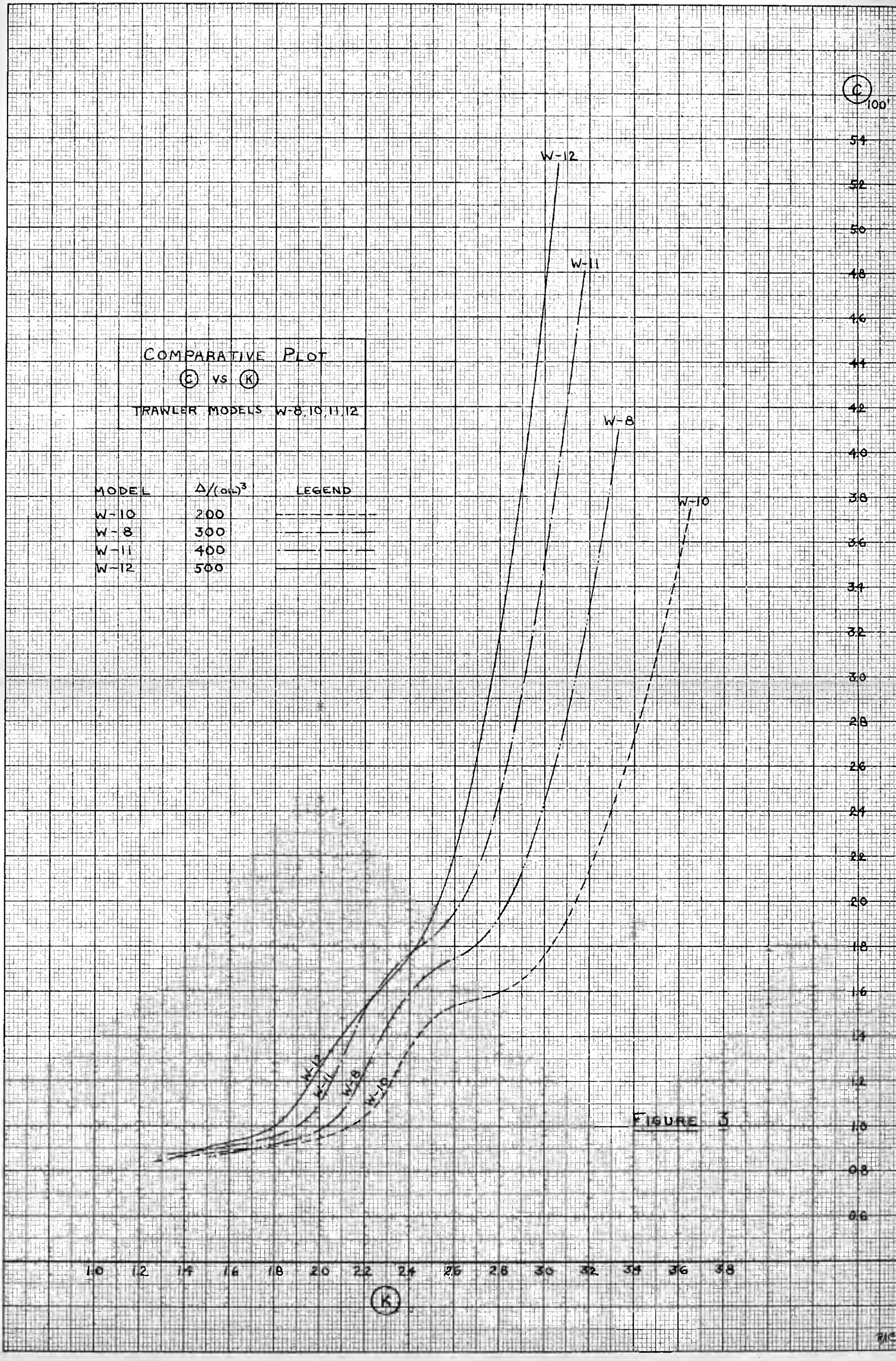
rapid. It might be surmised from these results that a displacement-length ratio model of 600 would produce a residual resistance curve without any hump or hollow at all. Norwegian data (8) on fishing boat models of varying displacement-length substantiates this assumption.

If the bow wave had no influence on the stern wave pattern, then a smooth resistance curve, without humps and hollows, would be the result. Accepting this premise, the authors have been able to derive some tentative conclusions. No doubt the flatter resistance curve of W-12 is caused by some change in the interaction between bow and stern wave patterns. Observation of the wave profile of W-12 in the speed range where humps and hollows could normally be expected reveals that the height of the second bow wave crest diminishes markedly near the side of the model, reaching a low point at the model itself. It appears that this would result in less bow wave interference with the stern wave pattern and, therefore, a flatter resistance curve.

Another possible explanation of the unusual shape of the resistance curve of W-12 is that the interference which could be expected between the bow and stern wave systems is opposed by the formation of another phenomenon such as a third wave system. An indication of this is evident in a definite disturbance in the bow wave pattern at a point on the hull near the low point of the first bow wave hollow just forward of amidships.

It is also considered entirely possible for a combination of these

two effects to be occurring, i.e. there is a decrease in the effect of the bow wave system on the stern wave syctem coupled with the formation of a third wave pattern. This combination could produce an overall decrease of the expected humps and hollows.


COMPARATIVE PLOT
C VS K
TRAWLER MODELS W-8,10,11,12
MODEL
Δ/(0.1L)³
LEGEND
W-10
200
W-8
300
W-11
400
W-12
500
W-12
W-11
W-8
W-10
C
100'
5.4
5.2
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
K
FIGURE 3

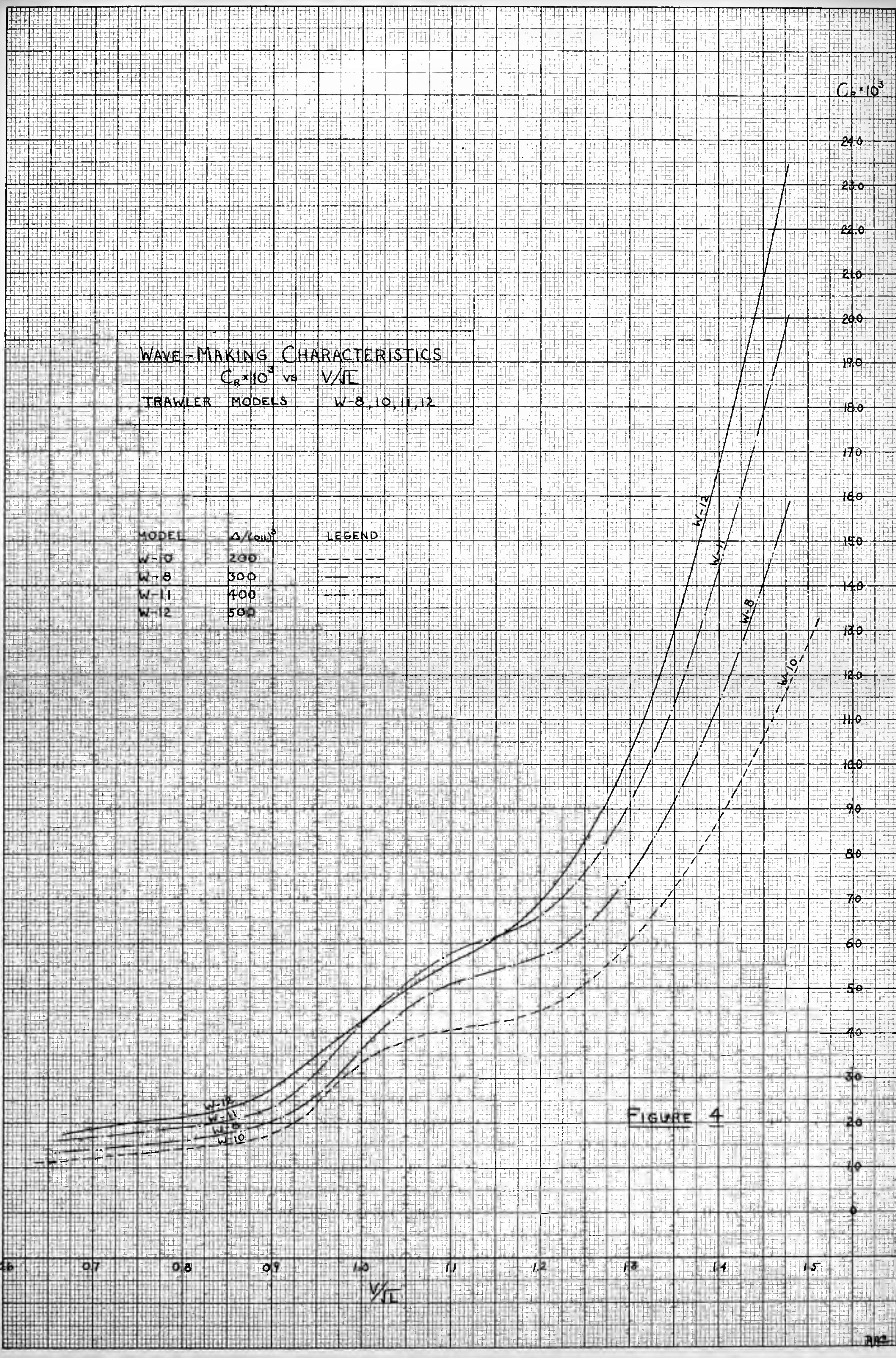

WAVE-MAKING CHARACTERISTICS
$C_R \times 10^3$ vs $V/\sqrt{L}$
TRAWLER MODELS W-8, 10, 11, 12
MODEL
$\Delta/(.01L)^3$
LEGEND
W-10 200
W-8 300
W-11 400
W-12 500
$C_R \cdot 10^3$
24.0
23.0
22.0
21.0
20.0
19.0
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
$V/\sqrt{L}$
W-12
W-11
W-8
W-10

FIGURE 4

b) Comparisons with ships of similar displacement-length ratio:

Figures 5A, 5B, and 5C are comparisons of models W-10, W-11, and W-12 expanded to 100 foot ships, with other vessels of similar displacement-length ratio and prismatic coefficient. In the case of models W-10 and W-11, the Japanese data of Takagi (9) permitted comparison with a standard series trawler form. It was also possible to compare these models with resistance data based on a series of tugs compiled by Taggart and published by Roach (10). W-10 at the lower speed values was within the Taylor Standard Series range (5), and hence, a third "series" comparison was available for this model. Due to its obesity, W-12 did not fall within the limits of any series and had to be compared with isolated vessels of high displacement-length ratio. Much useful information was obtained from a publication of fishing boat resistance data published by the Food and Agricultural Organization of the U. N. (11).

The probable presence of laminar flow at the lower values of K makes comparisons in this area of little value. Hence, observations will be confined to K values above about 1.8. As previously noted, turbulence inducement on models of higher displacement-length ratios is necessary to eliminate laminar flow. However, many of the resistance curves given in the FAO compilation (11) were determined with no turbulence stimulation. No discussion of turbulence stimulation is mentioned in Takagi. Inasmuch as the quantitative effect of the probable laminar flow is impossible to determine, no such allowance has been made on the comparative plots. However, it is to be noted that the

curves of those ships must be considered to be the minimum possible values of (C).

W-10 appears to be superior to all of the other comparisons with the exception of the Taylor Standard Series and a Dutch trawler listed in Figure 5A as FAO 21. The inferiority of the Takagi form is at once obvious. It is noted that even vessels with lower prismatics (FAO 61 and FAO 67) have considerably higher resistances. Particularly interesting is the fact that despite the apparent superiority of the Taylor and Dutch forms at the lower values, both cross over the W-10 curve well below a (K) equal to 2.65, corresponding to the design speed-length ratio of 1.1.

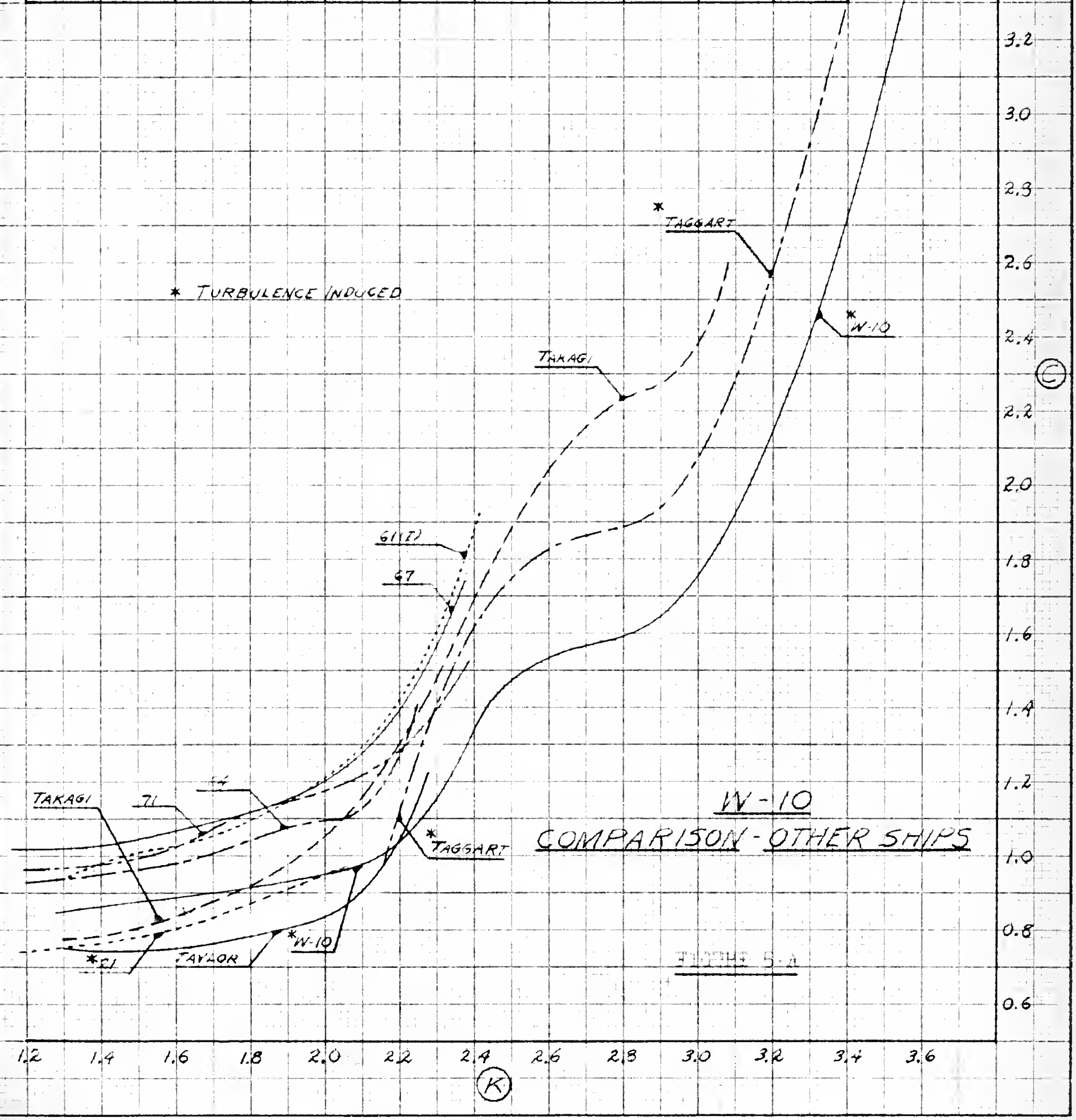
Similarly, W-11 appears to be quite superior to vessels in its range of displacement-length ratios. The Taggart "ship" has a most pronounced hump and hollow and the curve ends up well below W-11. However, at the designed (K), equal to about 2.35 for this model, W-11 is definitely superior to the composite tug boat form. Vessel FAO 79 shows up very favorably in comparison, but the lower resistance values can probably be ascribed to the considerably lower prismatic of this vessel. Note that turbulence was induced on this model.

At first glance, W-12 appears to be only moderately successful in comparison with the other forms. However, the TX-5 tug (one of the vessels used by Taggart in setting up his tug resistance contours), FAO 31Bb, and FAO 42Eb are the only vessels which fall below the W-12 curve, and these ships have prismatic coefficients of .623, .618, and

.611, respectively. The other three forms are well above W-12. Despite the fact that these vessels are above the 0.65 prismatic, observation of the relative positions of all the curves indicates that W-12 is definitely a good form. It will be noted that there is a definite lack of humps and hollows in these curves, as might be expected for vessels in this displacement-length range.

Unfortunately many of the comparisons had to be made with vessels of varying length and differing friction formulation. Time did not permit reanalysis of this data. However, from the somewhat artificial comparisons that have been made, the authors conclude that the displacement-length variations of the parent hull are very good hull forms and may be used successfully as part of a standard series.

	W-10	TAYLOR	TAGGART	TAKAGI	FAO VESSELS				
					21	6I(T)	64	67	71
LENGTH	100.0	100.0	100.0	100.0	100.0	124.7	137.8	120.7	128.0
BEAM	18.03	16.32		16.56	16.94	22.96	24.93	23.95	22.02
DRAFT	7.86	7.13		7.23	7.55	10.00	10.83	10.33	9.66
$\Delta/(.01L)^3$	200	200	200	200	238	214	236	236	192
C_p	.650	.650	.650	.650	.664	.648	.673	.639	.660
C_B	.494	.601		.535	.642	.496	.526	.475	.502
FRICTION	SCHOEN	SCHOEN	SCHOEN	SCHOEN	SCHOEN	FROUDE	FROUDE	FROUDE	FROUDE
REFERENCE		5	10	9	11	11	11	11	11



MODEL	W-11	TAGGART	TAKAGI	F.A.O. 2c	F.A.O. 4b	F.A.O. 30 Cb	F.A.O. 79
LENGTH	100'	100'	100'	106.8'	62.7'	60.3'	93.87'
BEAM	25.51'		23.40	24.0	17.4'	19.0'	24.2
DRAFT	11.12'		10.22	12.4	6.66'	7.16'	10.12
$\Delta/(.01L)^3$	400	400	400	397.3	409.7	403.2	383.2
C_P	.650	.650	.650	.652	.651	.630	.626
C_B	.494		.900	.531	.485	.375	.486
FRICT.	SCHOEN.	SCHOEN.	SCHOEN.	FROUDE	FROUDE	FROUDE	SCHOEN.
REF.		10	9	11	11	11	11

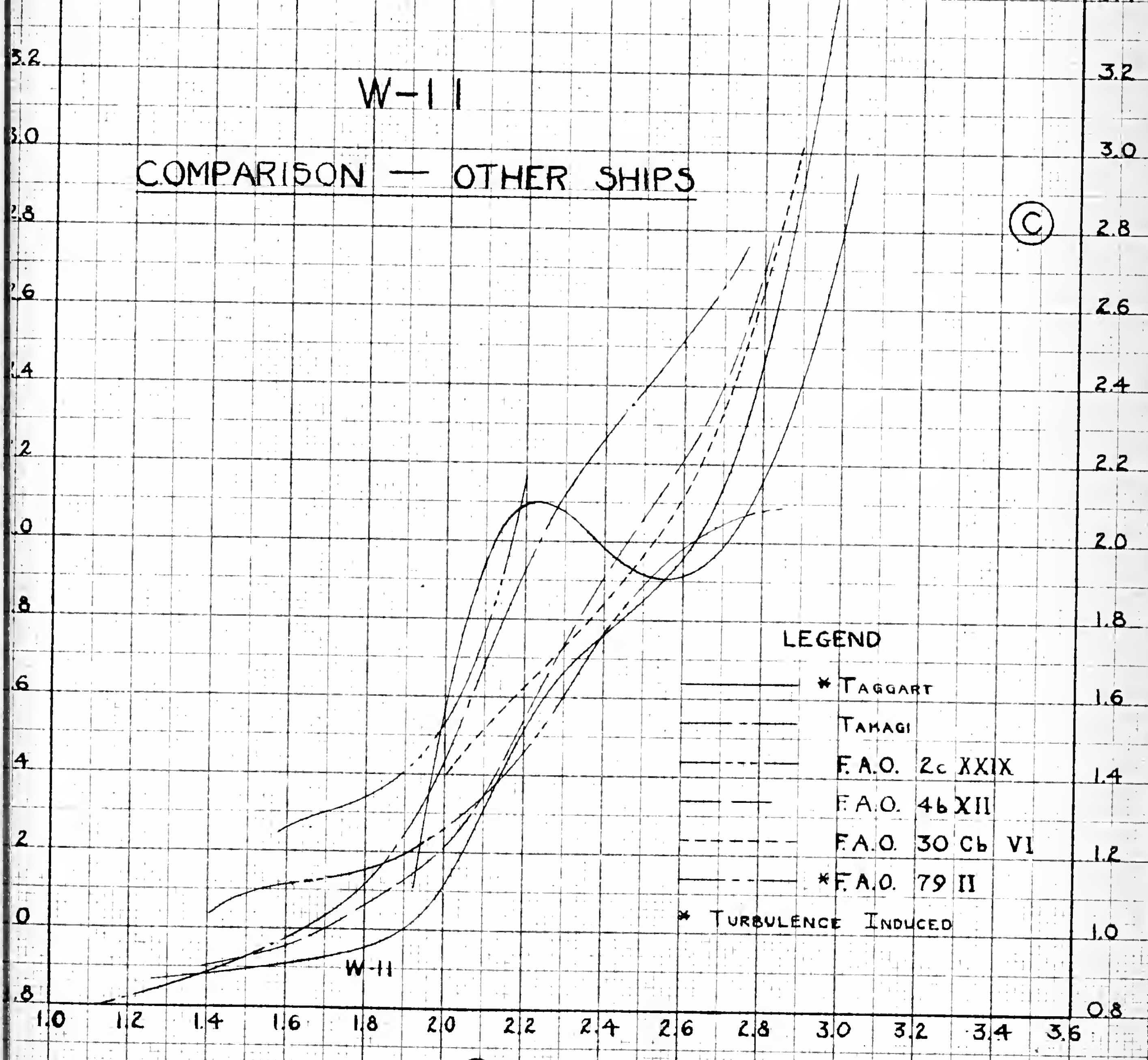


FIGURE 5-B

	W-12	TX-5	31Bb	39C	41Ab	42Eb	78
			FAO VESSELS				
LENGTH	100.0	100.0	68.4	70.3	66.84	66.85	86.58
BEAM	28.47	26.9	20.0	16.92	20.60	20.34	23.43
DRAFT	12.42	11.5	10.2	9.67	9.19	8.68	11.10
$\Delta/(.01L)^3$	500	481.5	486	489.5	536	535	474
C_P	.650	.623	.618	.705	.670	.611	.661
C_B	.494	.544	.390	.515	.442	.472	.526
FRICTION	SCHOEN.	SCHOEN.	FROUDE	FROUDE	FROUDE	FROUDE	SCHOEN.
REFERENCE		10	11	11	11	11	11

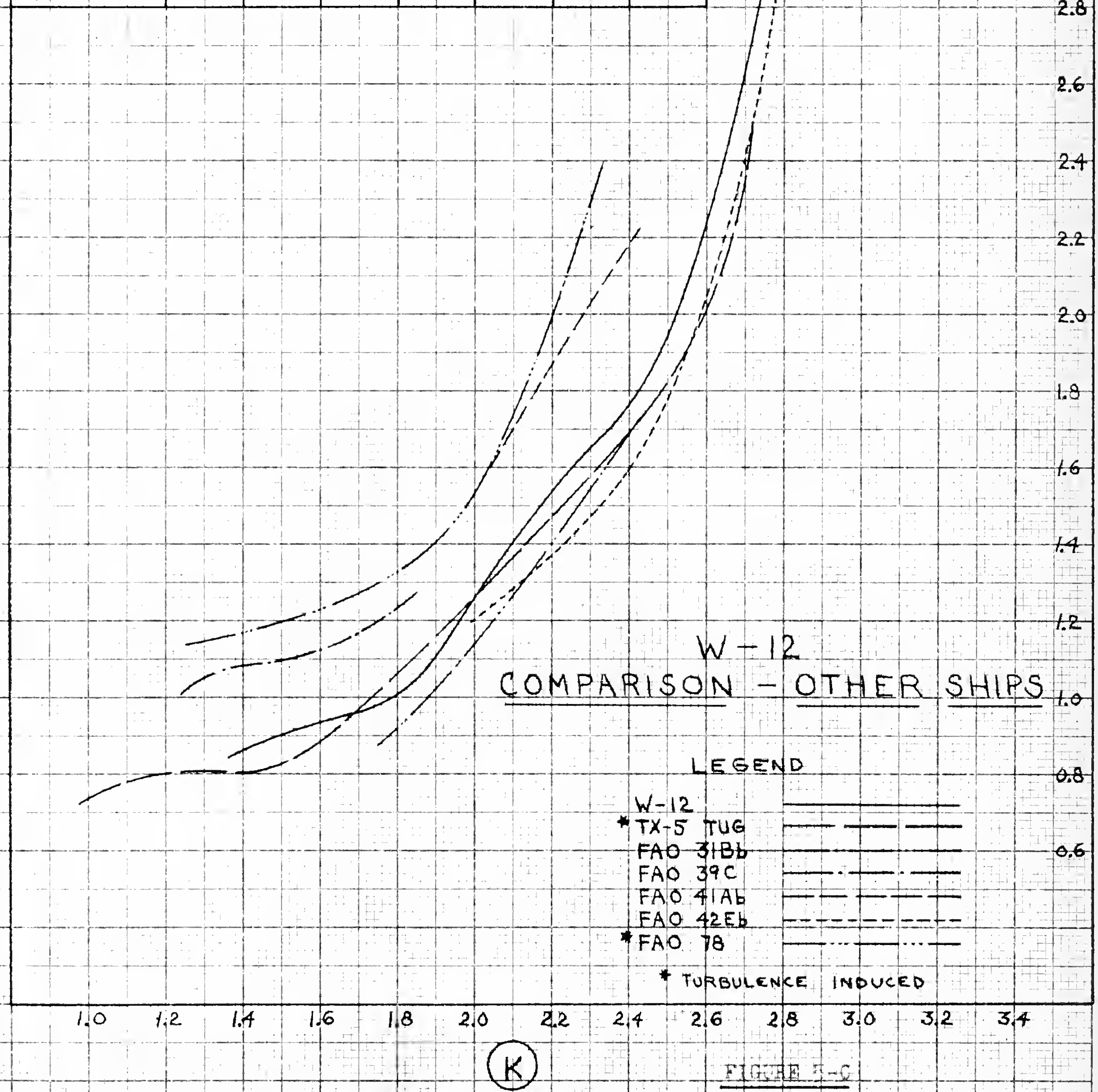


FIGURE 5-C

RAC

c) Summary of conclusions:

Models W-10, W-11, and W-12 have resistance curves which are generally lower than the majority of existing vessels of similar prismatic coefficient and displacement-length ratio. It is felt that models of a standard series should exhibit this characteristic to provide a mark of excellence toward which designers may strive.

Therefore, it is concluded that these models in conjunction with model W-8 will constitute an adequate and extremely useful series. Furthermore, it is considered that the range of 0.65 prismatic coefficients has been sufficiently explored and that the development of the series at other prismatics should follow.

BIBLIOGRAPHY

1. Chovit, Albert Rudolph, "A Statistical Analysis of Trawler Hulls for the determination of a High Displacement-Length Ratio Standard Series", Senior Thesis, Webb Institute of Naval Architecture, 1951.

2. Lerch, David William and Sims, John William, "Webb Standard Series--An Investigation of the Load Waterplane Coefficient". Senior Thesis, Webb Institute of Naval Architecture, 1952.

3. Burr, Arthur Alan; Dalzell, John Franklin; and Falci, Frank Paul; Webb Standard Series--An Investigation of the Effect of the Midship Section Coefficient and an Investigation of the Effect of the Variations of the Sectional Area Curve", Senior Thesis, Webb Institute of Naval Architecture, 1954.

4. Harvie, James, and Herreshoff, Halsey Chase, Webb Standard Series--Parent Hull Development", Senior Thesis, Webb Institute of Naval Architecture, 1955.

5. Gertler, Morton, "A Reanalysis of the Original Test Data for the Taylor Standard Series", Taylor Model Basin Report 806, Navy Department, Washington, 1954.

6. Ridgely-Nevitt, Cedric, "The Resistance of Trawler Hull Forms of 0.65 Prismatic Coefficient", paper to be presented at the annual meeting of The Society of Naval Architects and Marine Engineers in New York, November 1956.

7. Franklin, John Jay and Schwendtner, Alfred H., " An Investigation of Turbulent Flow Stimulating Devices for High Displacement-Length

Ratio Hulls", Senior Thesis, Webb Institute of Naval Architecture, 1954.

8. Astrup, N. Chr. and Sund, E., "Modellforsok med Fiskefartoyer", Del. I, Tekniske Skrifter, Nr N, 1952.

9. Takagi, Atsushi; Inui, Takao; and Nakamura, Shoichi, "Graphical Methods for Power Estimation of Fishing Boats", Fisheries Agency, 1950.

10. Roach, C. D., "Tugboat Design", and Taggart, Robert, discussion of paper "Tugboat Design" by C. D. Roach, Transactions of the Society of Naval Architects and Marine Engineers, 1954.

11. Food and Agriculture Organization of the United Nations, "Fishing Boat Tank Tests", Part One, Rome, 1955.

12. Taylor, D. W., "The Speed and Power of Ships", Third Edition, 1943.

13. Rossell, Henry E. and Chapman, Lawrence B., "Principles of Naval Architecture, Volume II", The Society of Naval Architects and Marine Engineers, 1949.

14. Van Lammeren, W. P. A.; Troost, L.; and Koning, J. G.: "Resistance, Propulsion, and Steering of Ships", 1948.

15. The Society of Naval Architects and Marine Engineers, "Explanatory Notes for Resistance and Propulsion Data Sheets", Technical and Research Bulletin No. 1-13.

A P P E N D I X

Table of Molded Offsets

Model W-8 $\frac{\Delta}{(.01L)^3} = 300$ Factor $= \sqrt{\frac{300}{300}} = 1.0$

Sta	Half Breadths - Waterlines 2	4	6	8	10	12	14	16	18	Main H B	Deck Height at Side	Buttock Heights Above Base 05	1	2	3	4	Heel Ht.	Sta.
Stem											10.91							Stem
F P					.06	.20	.47	.84	1.33	2.12	10.66	7.66	9.06	10.66				F P
½		[illegible]	.54	.79	1.01	1.27	1.63	2.10	2.77	3.50	10.36	3.20	5.58	8.59	10.08		1.77	½
1		[illegible]	1.26	1.64	1.95	2.26	2.64	3.17	3.85	4.28	10.11	1.97	2.77	5.98	8.57	10.09	1.33	1
1½		1.18	2.05	2.49	2.83	3.14	3.49	3.95	4.53	4.73	9.90	1.60	2.03	3.35	6.56	9.14	1.26	1½
2		1.71	2.76	3.28	3.62	3.89	4.18	4.54		4.83	9.18	1.40	1.71	2.47	4.05	7.69	1.18	2
3	.24	2.65	3.92	4.49	4.77	4.94	5.07			5.16	8.29	1.19	1.40	1.88	2.49	3.72	1.03	3
4	[illegible]	3.43	4.59	5.04	5.22	5.28	5.30			5.30	8.10	1.01	1.19	1.58	2.01	2.75	.87	4
5	[illegible]	3.73	4.77	5.19	5.30	5.30	5.30			5.30	8.06	.88	1.06	1.44	1.84	2.55	.73	5
6	.30	3.49	4.62	5.12	5.30	5.30	5.30			5.30	8.08	.73	.96	1.44	1.96	2.73	.58	6
7	.10	2.73	4.03	4.82	5.22	5.30	5.30			5.30	8.15	.69	1.04	1.73	2.47	3.45	.44	7
8	[illegible]	[illegible]	2.84	4.02	4.78	5.12	5.27			5.30	8.24	.94	1.64	2.62	3.50	4.53	.30	8
8½	[illegible]	[illegible]	2.14	3.38	4.33	4.87	5.11			5.21	8.29	1.46	2.25	3.20	4.11	5.24	.22	8½
9	[illegible]	[illegible]	1.30	2.57	3.72	4.42	4.75			4.90	8.38	2.24	2.96	3.93	4.81	6.05	.15	9
9½	.09	.14	.37	1.50	2.77	3.64	4.11			4.28	8.53	3.45	3.94	4.78	5.79	8.10	.07	9½
A P					1.43	2.46	2.99	3.26		3.29	8.70	4.74	5.09	5.99	8.13		4.43	A P
Stern											8.99							Stern
Deck												10.87	10.81	10.66	10.44	10.12		Deck

Offsets W-8

Table I

Table of Molded Offsets

Model W-10 $\qquad \frac{\Delta}{(.01L)^3} = 200 \qquad$ Factor $= \sqrt{\frac{200}{300}} = .8165$

Sta.	Half Breadths - Waterlines 2	.4	6	8	1.0	1.2	1.4	1.6	1.8	Main H.B.	Deck Height at Side	Buttock Heights Above Base .05	1	2	3	4	Heel Ht	Sta.
Stem											8.91							Stem
F.P.					.05	.16	.38	.68	1.08	1.73	8.70	6.25	7.40	8.70				F.P.
½		.16	.44	.64	.82	1.04	1.33	1.71	2.26	2.36	8.46	2.61	4.56	7.01	8.23		1.36	½
1		.54	1.03	1.34	1.59	1.84	2.16	2.59	3.14	3.49	8.25	1.61	2.26	4.88	7.00	8.24	1.09	1
1½		.96	1.67	2.03	2.31	2.56	2.85	3.22	3.70	3.86	8.08	1.31	1.66	2.74	5.36	7.46	1.03	1½
2		2.40	2.25	2.68	2.96	3.18	3.41	3.71		3.94	7.50	1.14	1.40	2.02	3.31	6.28	.96	2
3	.20	2.16	3.20	3.67	3.89	4.03	4.14			4.21	6.77	.97	1.14	1.54	2.03	3.04	.84	3
4	.58	2.90	3.75	4.12	4.26	4.31	4.33			4.33	6.61	.82	.97	1.29	1.64	2.24	.72	4
5	.87	3.04	3.89	4.24	4.33	4.33	4.33			4.33	6.58	.72	.86	1.18	1.50	2.08	.60	5
6	1.06	2.85	3.77	4.18	4.33	4.33	4.33			4.33	6.60	.60	.78	1.18	1.60	2.23	.48	6
7	.90	2.23	3.29	3.94	4.26	4.33	4.33			4.33	6.65	.56	.85	1.41	2.02	2.32	.36	7
8	.49	1.28	2.32	3.28	3.90	4.18	4.30			4.33	6.73	.77	1.34	2.14	2.86	3.70	.24	8
8½	.31	.78	1.75	2.76	3.54	3.98	4.17			4.25	6.77	1.19	1.84	2.61	3.36	4.28	.18	8½
9	.17	.38	1.06	2.10	3.04	3.61	3.56			4.00	6.34	1.83	2.42	3.21	3.93	4.94	.12	9
9½	.07	.11	.30	1.22	2.26	2.97	3.36			3.49	6.96	2.32	3.22	3.90	4.73	6.61	.06	9½
A.P.					1.17	2.01	2.44	2.66		2.69	7.10	3.87	4.16	4.89	6.64		3.62	A.P.
Stern											7.34							Stern
Deck												8.88	8.33	8.70	8.52	8.26		Deck

OFFSETS

W-10

TABLE IIA

Table of Molded Offsets

Model W-11 $\frac{\Delta}{(.01L)^3} = 400$ Factor $= \sqrt{\frac{400}{300}} = 1.155$

Sta	Half Breadths - Waterlines 2	.4	6	.8	1.0	1.2	1.4	1.6	1.8	Main HB	Deck Height at Side	Buttock Heights Above Base 05	1	2	3	4	Heel Ht.	Sta.
Stem											12.60							Stem
FP					.07	.23	.54	.97	1.54	2.45	12.31	8.85	10.46	12.31				FP
1/2		.23	.62	.91	1.17	1.47	1.88	2.43	3.20	4.04	11.97	3.70	6.44	9.92	11.64		2.04	1/2
1		.76	1.46	1.89	2.25	2.61	3.05	3.66	4.45	4.94	11.68	2.28	3.20	6.91	9.90	11.65	1.54	1
1 1/2		1.36	2.37	2.88	3.27	3.63	4.03	4.56	5.23	5.46	11.43	1.85	2.34	3.87	7.58	10.56	1.46	1 1/2
2		1.98	3.19	3.79	4.18	4.49	4.83	5.24		5.58	10.60	1.62	1.98	2.85	4.68	8.88	1.36	2
3	.28	3.06	4.53	5.19	5.51	5.71	5.86			5.96	9.57	1.37	1.62	2.17	2.88	4.30	1.19	3
4	.82	3.96	5.30	5.82	6.03	6.10	6.12			6.12	9.36	1.17	1.37	1.82	2.32	3.18	1.00	4
5	1.24	4.31	5.51	5.99	6.12	6.12	6.12			6.12	9.31	1.02	1.22	1.66	2.13	2.95	.84	5
6	1.50	4.03	5.34	5.91	6.12	6.12	6.12			6.12	9.33	.84	1.09	1.66	2.26	3.15	.67	6
7	1.27	3.15	4.65	5.57	6.03	6.12	6.12			6.12	9.41	.80	1.20	2.00	2.85	3.98	.51	7
8	.69	1.81	3.28	4.64	5.51	5.91	6.09			6.12	9.52	1.09	1.89	3.03	4.04	5.23	.35	8
8 1/2	.44	1.10	2.47	3.90	5.00	5.62	5.90			6.02	9.57	1.69	2.60	3.70	4.75	6.05	.25	8 1/2
9	.24	.54	1.50	2.97	4.30	5.11	5.49			5.66	9.68	2.59	3.42	4.54	5.56	6.99	.17	9
9 1/2	.10	.16	.43	1.73	3.20	4.20	4.75			4.94	9.85	3.98	4.55	5.52	6.69	9.36	.08	9 1/2
AP					1.65	2.84	3.45	3.77		3.80	10.05	5.47	5.88	6.92	9.39		5.12	AP
Stern											10.38							Stern
Deck												12.55	12.49	12.31	12.06	11.69		Deck

Offsets W-11

Table II-B

Table of Molded Offsets

Model W-12 $\qquad \frac{\Delta}{(.01L)^3} = 500 \qquad$ Factor $= \sqrt{\frac{500}{300}} = 1.291$

Sta	Half Breadths - Waterlines 2	4	6	8	10	12	14	16	18	Main H.B.	Deck Height at Side	Buttock Heights Above Base 0	1	2	3	4	Heel Ht.	Sta.
Stem											14.08							Stem
F.P.					.08	.26	.61	1.08	1.72	2.74	13.76	9.89	11.70	13.76				F.P.
½		.26	.70	1.02	1.30	1.64	2.10	2.71	3.58	4.52	13.37	4.13	7.20	11.09	13.01		2.29	½
1		.85	1.63	2.12	2.52	2.92	3.41	4.09	4.97	5.53	13.05	2.54	3.58	7.72	11.06	13.03	1.72	1
1½		1.52	2.65	3.21	3.65	4.05	4.51	5.10	5.85	6.11	12.78	2.07	2.62	4.32	8.47	11.80	1.63	1½
2		2.21	3.56	4.23	4.67	5.02	5.40	5.86		6.24	11.85	1.81	2.21	3.19	5.23	9.93	1.52	2
3	.31	3.42	5.06	5.80	6.16	6.38	6.55			6.66	10.70	1.54	1.81	2.43	3.21	4.80	1.33	3
4	.92	4.43	5.93	6.51	6.74	6.82	6.84			6.84	10.46	1.30	1.54	2.04	2.59	3.55	1.12	4
5	1.38	4.82	6.16	6.70	6.84	6.84	6.84			6.84	10.41	1.14	1.37	1.86	2.38	3.29	.94	5
6	1.68	4.51	5.96	6.84	6.84	6.84	6.84			6.84	10.43	.94	1.24	1.86	2.53	3.52	.75	6
7	1.42	3.52	5.20	6.22	6.74	6.84	6.84			6.84	10.52	.89	1.34	2.23	3.19	4.45	.57	7
8	.77	2.03	3.67	5.19	6.17	6.61	6.80			6.84	10.64	1.21	2.12	3.38	4.52	5.85	.39	8
8½	.49	1.23	2.76	4.36	5.59	6.29	6.60			6.73	10.70	1.88	2.90	4.13	5.31	6.76	.28	8½
9	.27	.61	1.68	3.32	4.80	5.71	6.13			6.33	10.82	2.89	3.82	5.07	6.21	7.81	.19	9
9½	.12	.18	.48	1.94	3.58	4.70	5.31			5.53	11.01	4.45	5.09	6.17	7.47	10.46	.10	9½
A.P.					1.85	3.18	3.86	4.21		4.25	11.23	6.12	6.57	7.73	10.50		5.72	A.P.
Stern											11.61							Stern
Deck												14.03	13.96	13.76	13.48	13.06		Deck

OFFSETS
W-12

Table II-C

TABLE III

SUMMARY OF TRAWLER MODEL CHARACTERISTICS

MODEL		W-10	W-11	W-12
L. O. A.	in.	53.55	53.55	53.55
L. W. L.	in.	49.50	49.50	49.50
L. B. P.	in.	48.00	48.00	48.00
Beam, mld.	in.	8.66	12.24	13.68
Draft, mld.	in.	3.77	5.34	5.95
Draft, extreme	in.	4.33	6.12	6.84
Displ. in 80°F F. W.	in.	7.87	55.73	69.67
Wetted Surface	sq. ft.	3.55	5.02	5.59
Drag B. P.	in.	1.18	1.66	1.86
Freeboard to gage blocks	in.	3.13	3.97	4.45
Beam-Draft Ratio		2.29	2.29	2.29
Displacement-Length Ratio		200	400	500
Block Coefficient		.494	.494	.494
Prismatic Coefficient		.650	.650	.650
Midship Section Coefficient		.760	.760	.760
Waterplane Coefficient		.779	.779	.779
Vertical Prismatic Coefficient		.634	.634	.634
Drag/L. B. P.		.0245	.0346	.0387
L. C. B./L. B. P., aft of F. P.		.5155	.5155	.5155

SUMMARY OF TRAWLER MODEL CHARACTERISTICS

	W-1	W-2	W-3	W-4	W-5	W-6	W-7	W-8	W-9	W-10	W-11	W-12
Length B.P.	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Length, L.W.L.	102.62	102.62	102.62	101.94	102.60	103.52	101.92	103.12	105.90	103.12	103.12	103.12
Beam, Mld.	21.44	21.44	21.44	20.01	23.04	21.44	21.44	22.06	22.08	18.03	25.51	28.47
Draft, Amidships	9.27	9.27	9.29	8.73	10.02	9.33	9.33	9.63	9.66	7.86	11.12	12.42
Drag, Based on L.B.P.	2.14	1.31	2.14	2.14	2.14	2.14	2.14	3.00	2.50	2.45	3.46	3.87
Displacement, S.W., tons	300.	300.	300.	300.	300.	300.	300.	300.	300.	200	400	500
Wetted Surface, sq. ft.	2667.	2662.	2727.	2635.	2791.	2721.	2637.	2715.	2712.	2216	3135	3491
Block Coef.	0.528	0.528	0.527	0.598	0.455	0.524	0.525	0.494	0.492	0.494	0.494	0.494
Prismatic Coef.	0.652	0.652	0.652	0.650	0.650	0.649	0.648	0.650	0.650	0.650	0.650	0.650
Midship Section Coef.	0.810	0.810	0.809	0.921	0.700	0.807	0.810	0.760	0.758	0.760	0.760	0.760
Waterplane Coef.	0.790	0.701	0.863	0.787	0.788	0.800	0.773	0.779	0.766	0.779	0.779	0.779
Vertical Prismatic Coef.	0.668	0.753	0.611	0.760	0.577	0.655	0.679	0.634	0.642	0.634	0.634	0.634
L.B.P./Beam	4.665	4.665	4.665	4.975	4.340	4.665	4.665	4.529	4.529	5.546	3.921	3.512
L.B.P./Draft Amidships	10.79	10.79	10.76	11.45	9.98	10.71	10.71	10.38	10.35	12.72	8.99	8.05
Beam/Draft Amidships	2.31	2.31	2.31	2.30	2.30	2.30	2.30	2.29	2.29	2.29	2.29	2.29
Drag/L.B.P.	0.0214	0.0131	0.0214	0.0214	0.0214	0.0214	0.0214	0.0300	0.0250	0.0245	0.0346	0.0387
L.C.B./L.B.P., Aft of F.P.	0.5154	0.5152	0.5152	0.5150	0.5157	0.5153	0.5155	0.5155	0.5150	0.5155	0.5155	0.5155
$\Delta/(0.01 \cdot L)^3$	300.	300.	300.	300.	300.	300.	300.	300.	300.	200	400	500
$\nabla/(\cancel{0.00}1 \cdot L)^3$	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	7.0	14.0	17.5
$S/\sqrt{\nabla \cdot L}$	2.60	2.59	2.66	2.57	2.72	2.65	2.57	2.65	2.65	2.65	2.65	2.65
1/2 Entrance Angle, degrees	21.	8.	37.	20.	21.	20.	22.	22.	19.	18	24.5	26
Taylor "t"	0.60	0.60	0.60	0.60	0.60	1.60	0.25	0.90	0.90	0.90	0.90	0.90

TABLE V

FORMULAE AND SYMBOLS

C_f — Frictional-resistance coefficient, $\dfrac{R_f}{\frac{\rho}{2}SV^2}$

where V is in ft/sec

C_r — Residual-resistance coefficient, $\dfrac{R_r}{\frac{\rho}{2}SV^2}$

C_t — Total-resistance coefficient, $\dfrac{R_t}{\frac{\rho}{2}SV^2}$

Ⓒ — Total-resistance coefficient (circle coefficient system), $\dfrac{1000}{8\pi} \cdot \dfrac{S}{\nabla^{2/3}} \cdot C_t$

Ⓚ — Speed coefficient (circle coefficient system), $\dfrac{V}{\nabla^{1/6}}\sqrt{\dfrac{4\pi}{g}}$

where V is in ft/sec

EHP — Effective horsepower, $\dfrac{C_t \cdot \frac{\rho}{2}SV^3}{550 \text{ ft-lb/sec}} = AV_k^3C_t$

where V_k is knots
$A = 0.00438\rho S$

R_e — Reynold's number, $\dfrac{VL}{\nu}$

where V is in ft/sec
L = L.W.L.

R_f — Frictional resistance in lbs.

R_r — Residual resistance in lbs.

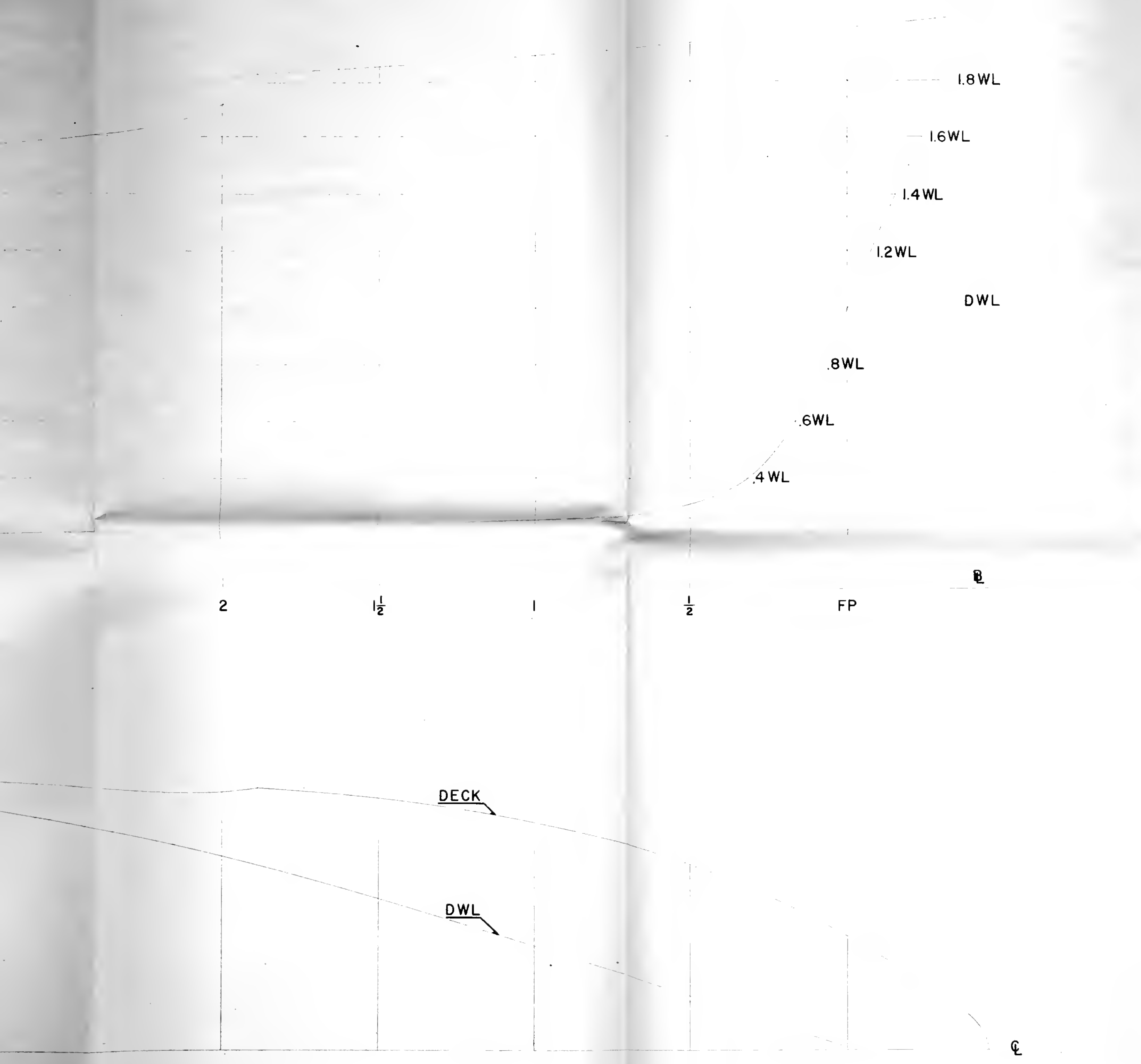
R_t — Total resistance in lbs.

S — Wetted surface in sq. ft.

V	Speed in ft/sec or knots, as noted
$V/\sqrt{gL}$	Froude number, where V is in ft/sec, L = L.B.P.
$V/\sqrt{L}$	Speed-length ratio, where V is knots, L = L.B.P.
Δ	Tons of displacement in salt water
∇	Immersed volume in cu. ft.
ρ	Density of water in lb-sec^2/ft^4
ν	Kinematic viscosity of water in ft^2/sec


1.6 WL
1.4WL
1.2WL
DWL
.8 WL
.6WL
.4WL
.2WL
BL
AP
9½
9
8½
8
7
6
DECK
DWL
CL

.05B
.1B
.2B
.3B
.4B
.4B
.3B
.2B
.1B
.05B
0
½
1
1½
2
3
4
5
10
9½
9
8½
8
7
6
7
6
4
3
2
1½



HULL PARTICULARS

SHIP		MODEL
111.56'	LENGTH OVERALL	53.55"
100.00'	LENGTH BETWEEN PERPENDICULARS	48.00"
103.12'	LENGTH WATERLINE	49.50"
18.03'	BEAM, MOLDED	8.65"
7.86'	DRAFT, MOLDED	3.77"
9.01'	DRAFT, EXTREME	4.33"
200^T S.W.	DISPLACEMENT	22.87# F.W.
.494	BLOCK COEFFICIENT	.494
.650	PRISMATIC COEFFICIENT	.650
.760	MIDSHIP COEFFICIENT	.760
.779	WATERPLANE COEFFICIENT	.779
.5155	LCB/LBP AFT OF F.P.	.5155

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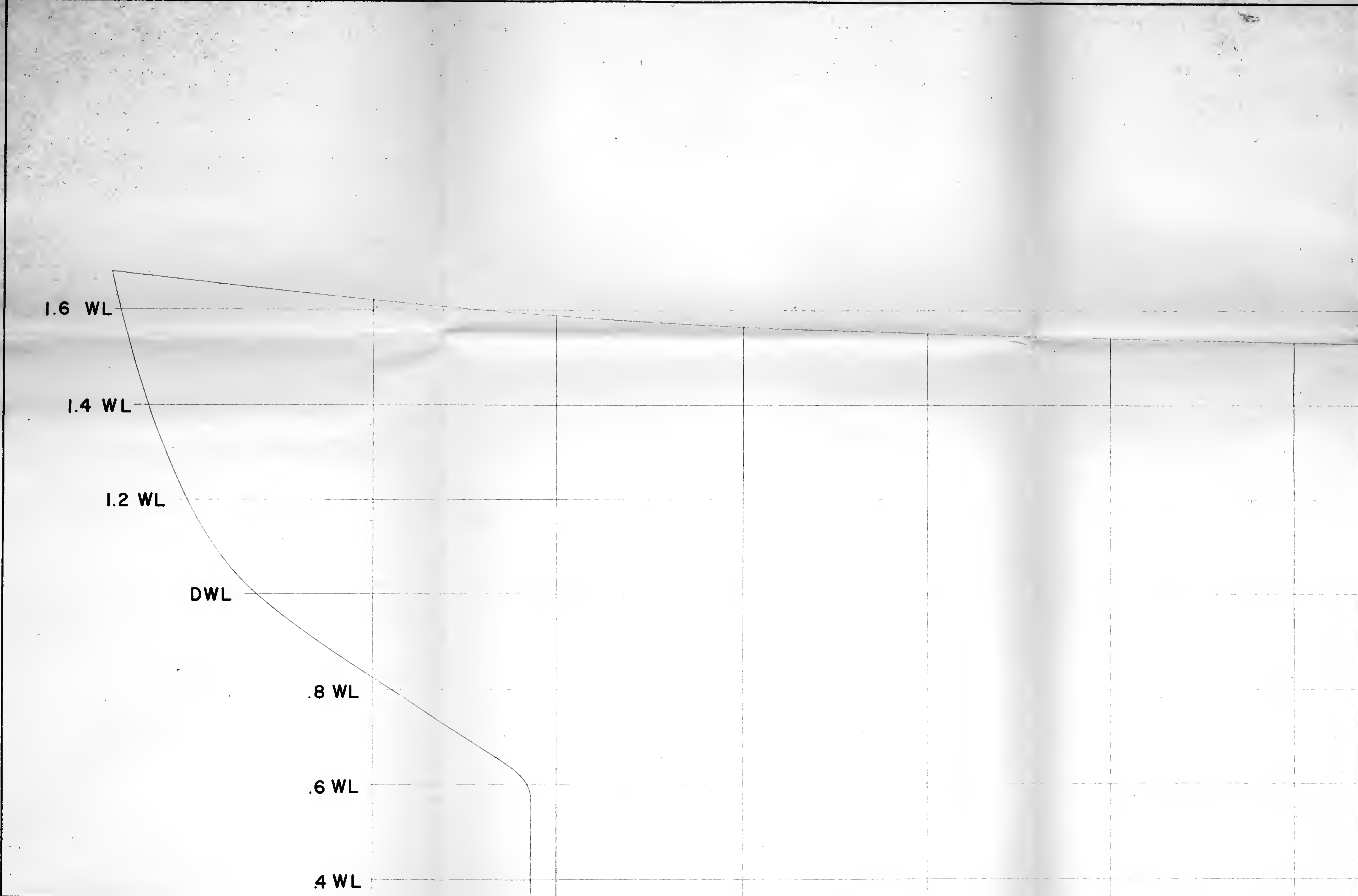
MODEL W-10

SCALE - FULL SIZE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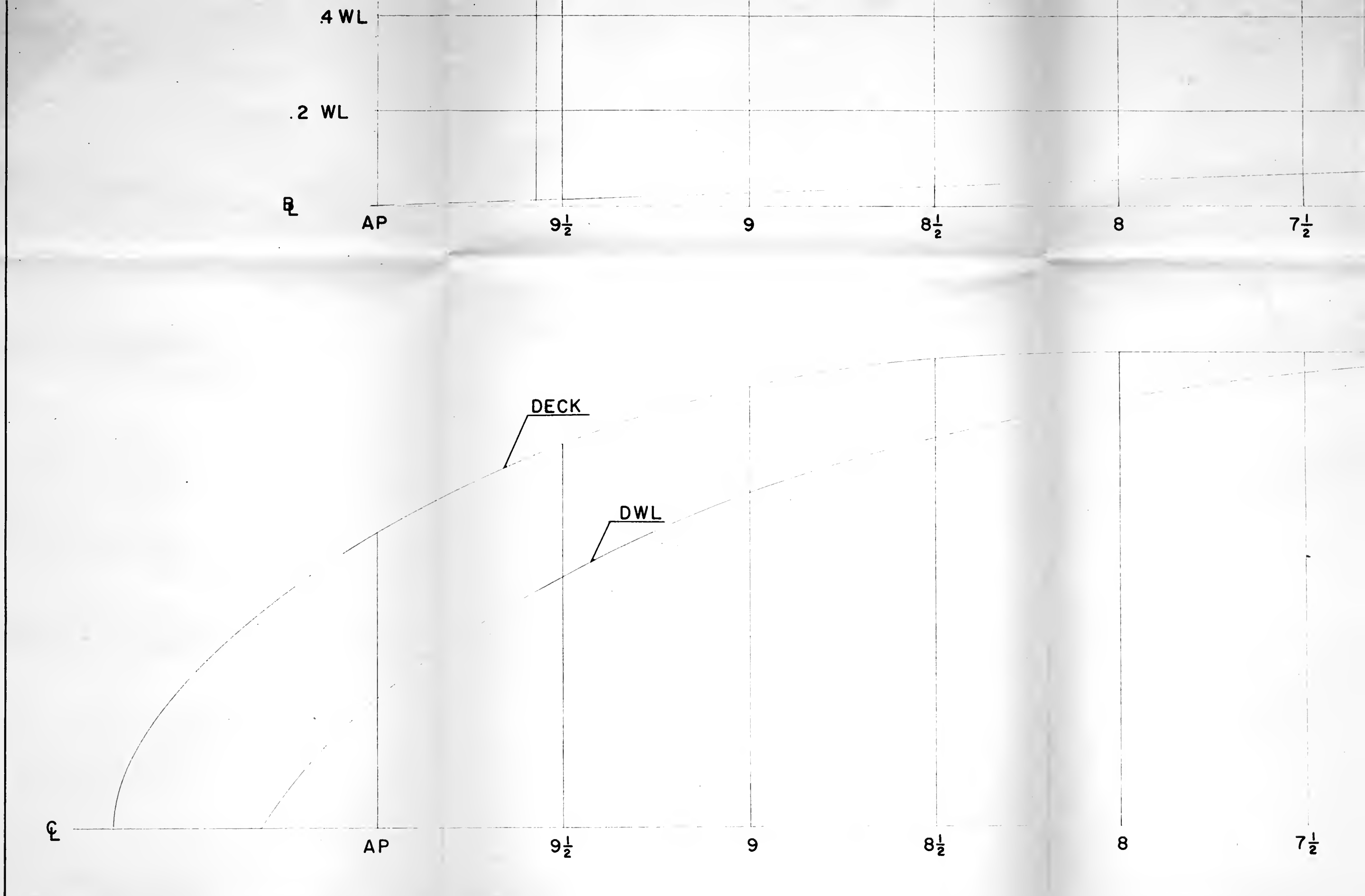
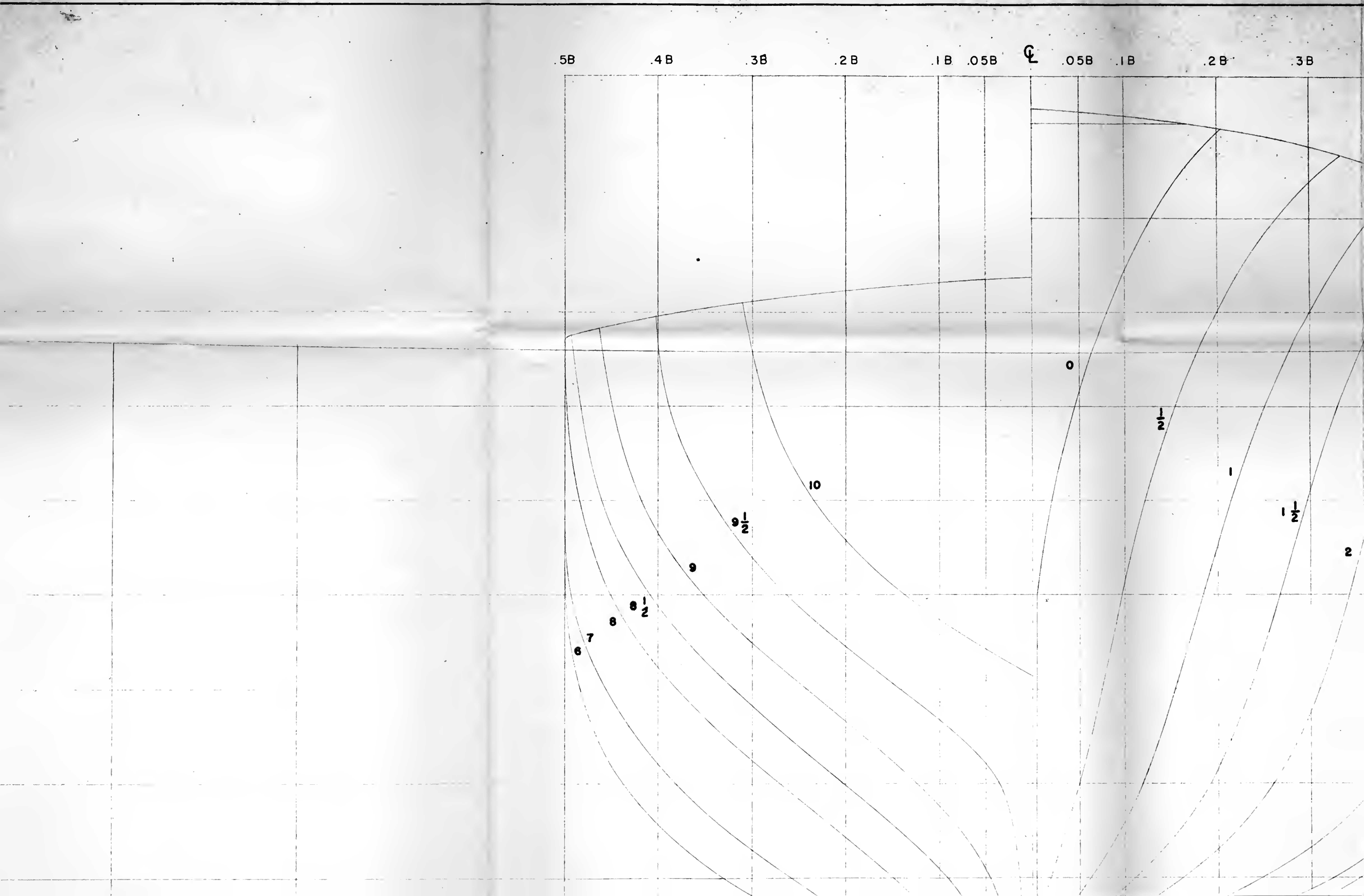
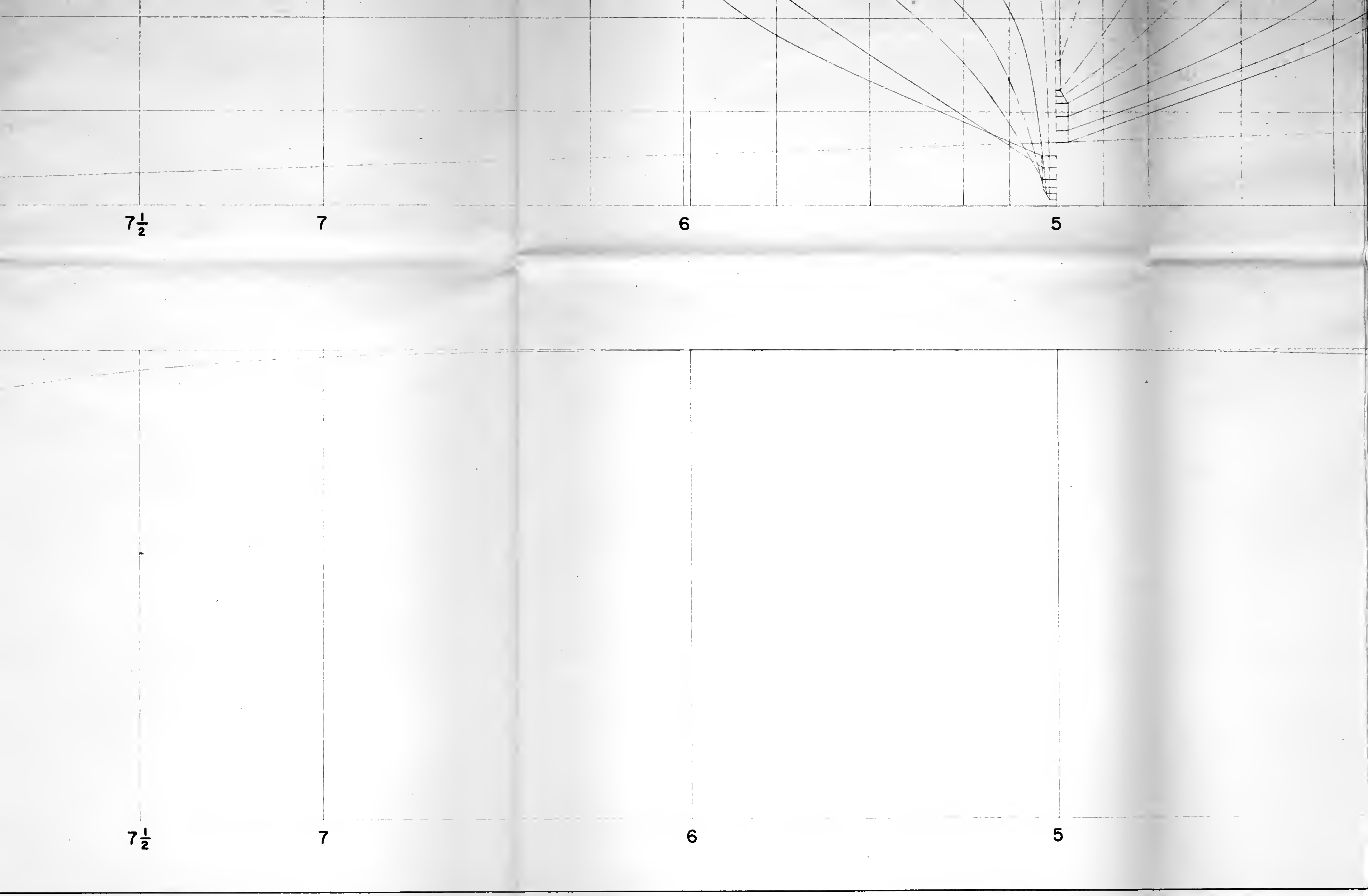
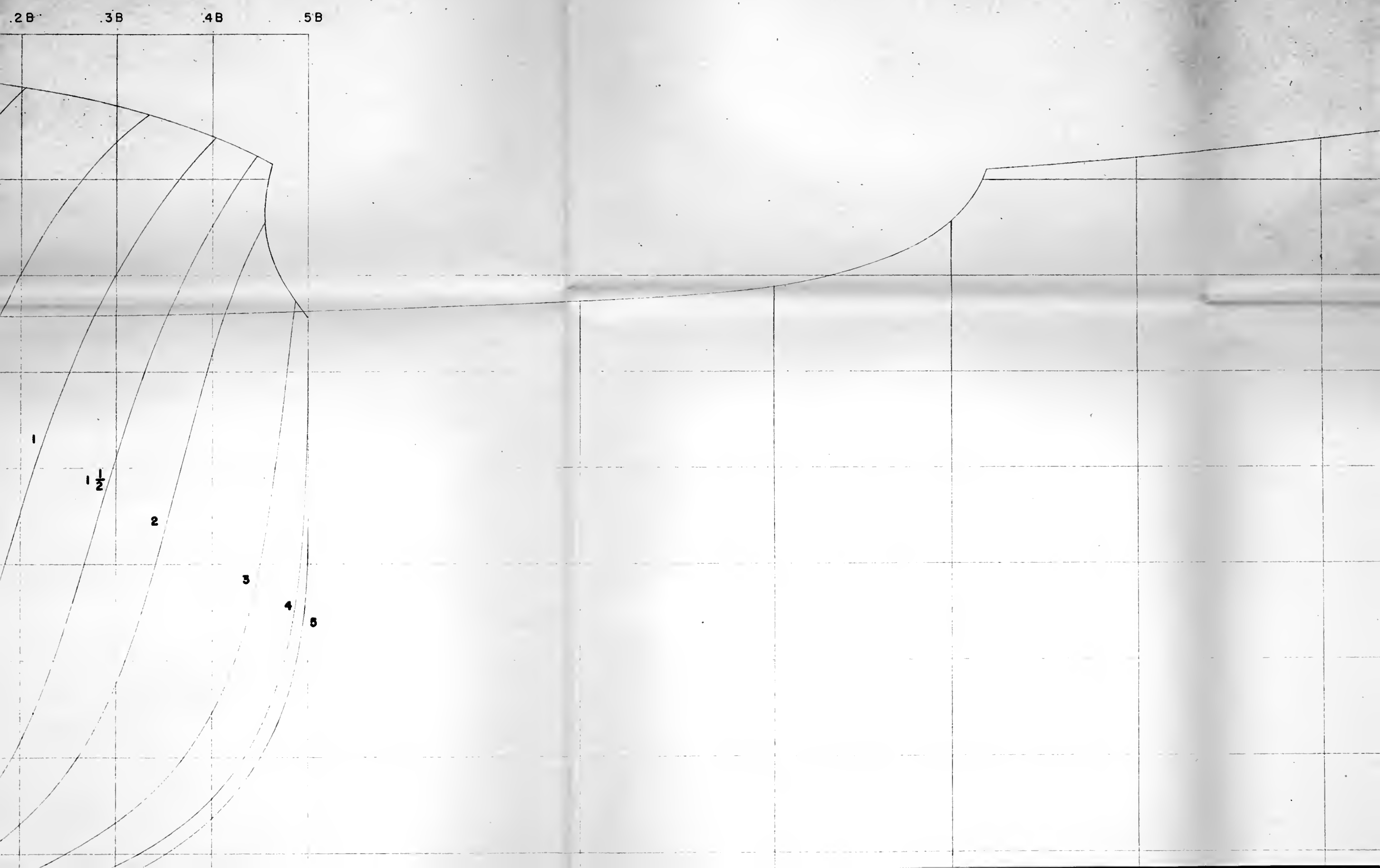
1.2 WL
DWL
.8 WL
.6 WL
.4 WL


.4 WL
.2 WL
BL
AP
9½
9
8½
8
7½
DECK
DWL
CL
AP
9½
9
8½
8
7½

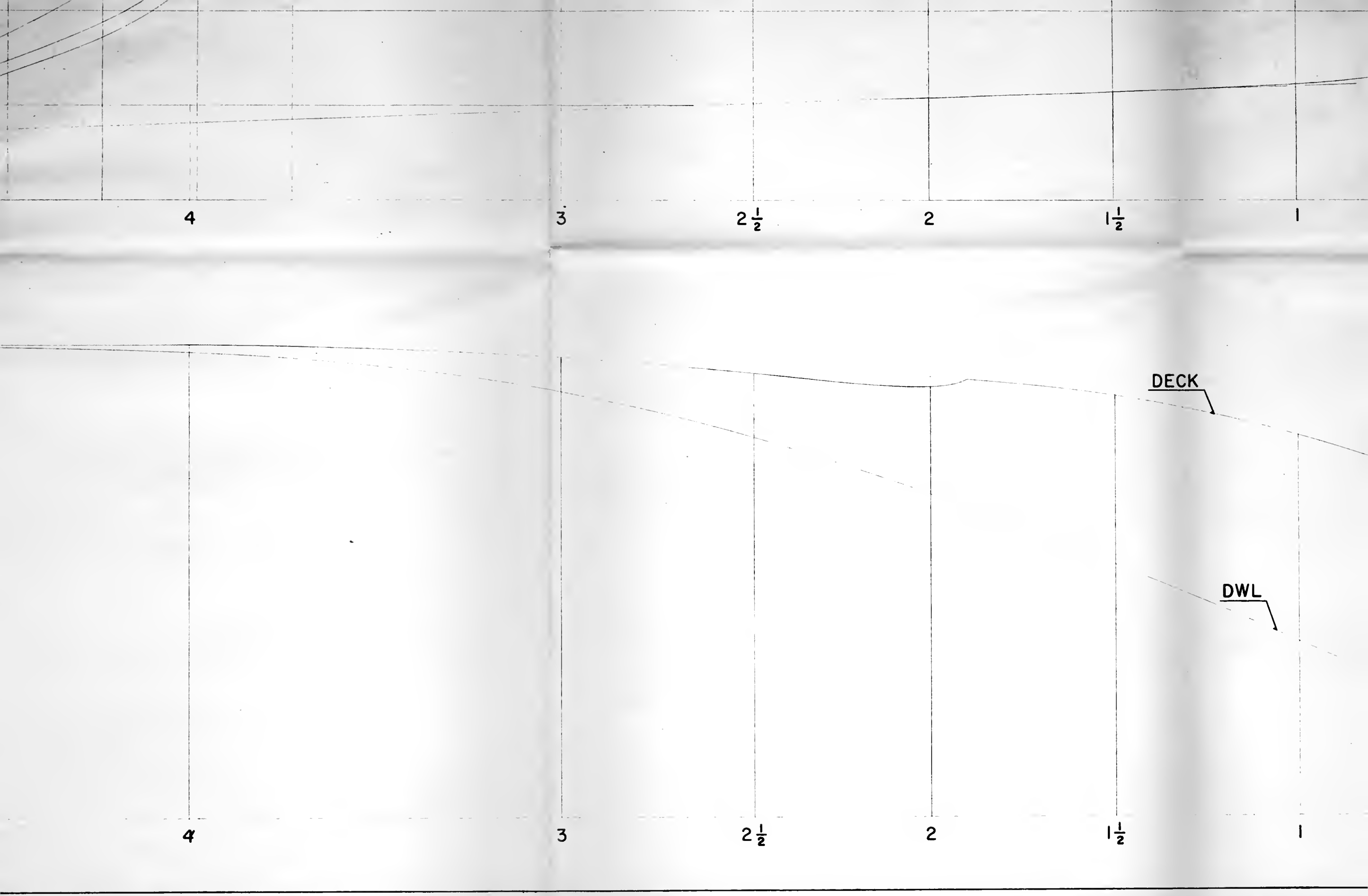


.5B
.4B
.3B
.2B
.1B
.05B
CL
.05B
.1B
.2B
.3B
0
1/2
1
1 1/2
2
10
9 1/2
9
8 1/2
8
7
6


7½
7
6
5
7½
7
6
5



.2B
.3B
.4B
.5B
1
1 1/2
2
3
4
5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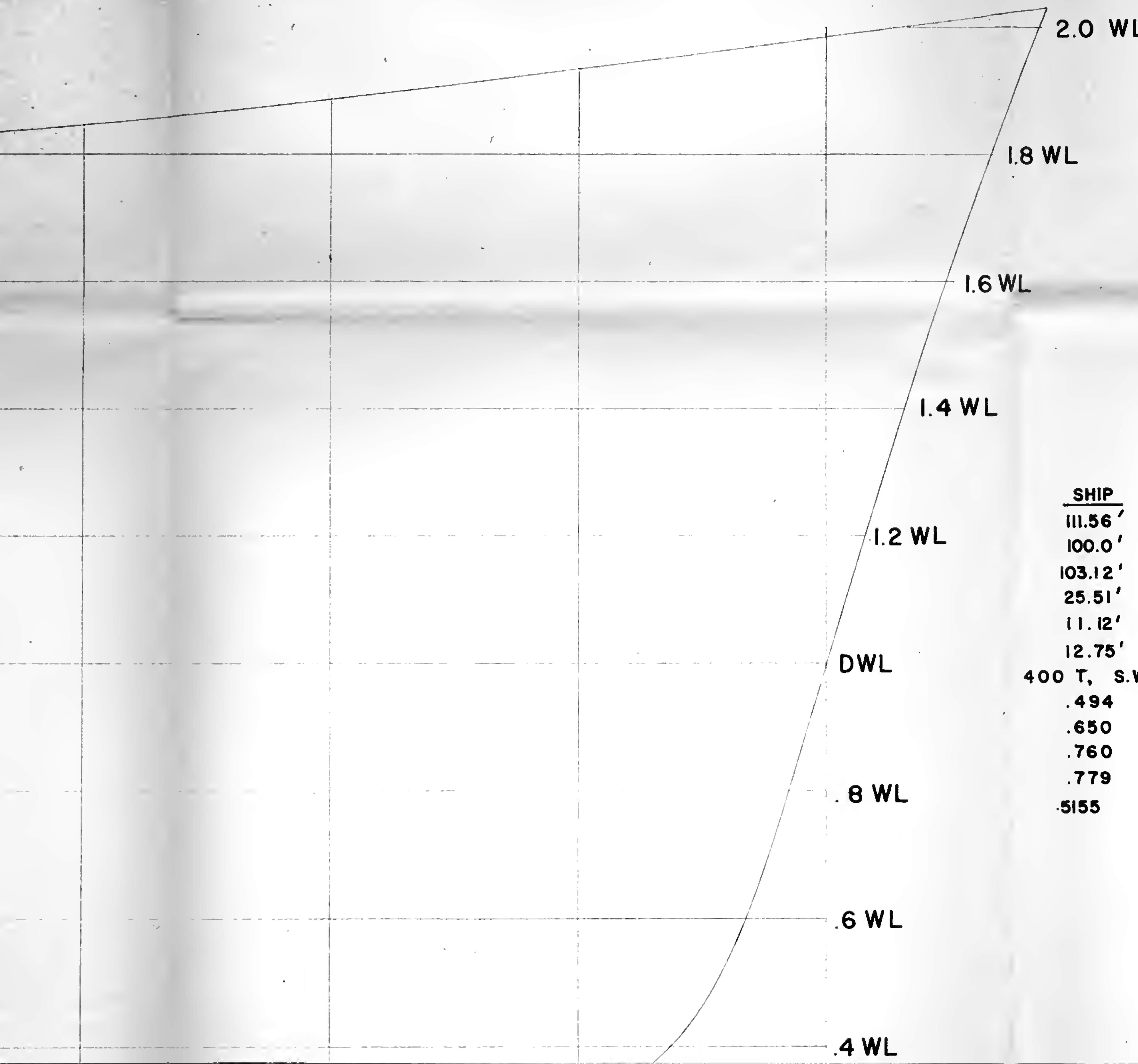
3
2 1/2
2
1 1/2
1
DECK
DWL
4
3
2 1/2
2
1 1/2
1



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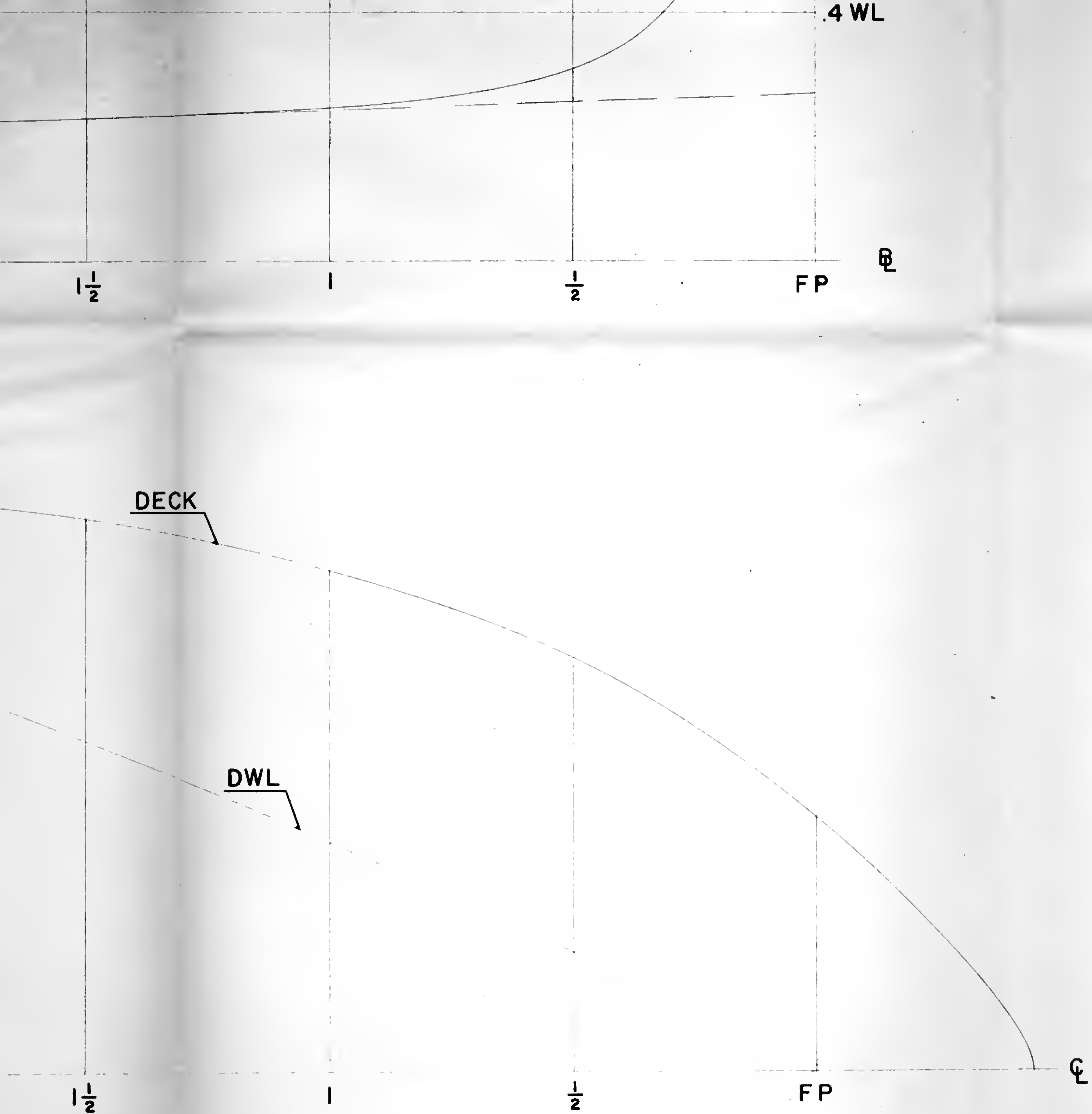
HULL PARTICULARS

SHIP		MODEL
111.56′	LENGTH OVERALL	53.55″
100.0′	LENGTH BETWEEN PERPENDICULARS	48.00″
103.12′	LENGTH WATERLINE	49.50″
25.51′	BEAM, MOLDED	12.24″
11.12′	DRAFT, MOLDED	5.34″
12.75′	DRAFT, EXTREME	6.12″
400 T, S.W.	DISPLACEMENT	55.73 #, F.W.
.494	BLOCK COEFFICIENT	.494
.650	PRISMATIC COEFFICIENT	.650
.760	MIDSHIP COEFFICIENT	.760
.779	WATERPLANE COEFFICIENT	.779
.5155	LCB/LBP AFT OF F.P.	.5155



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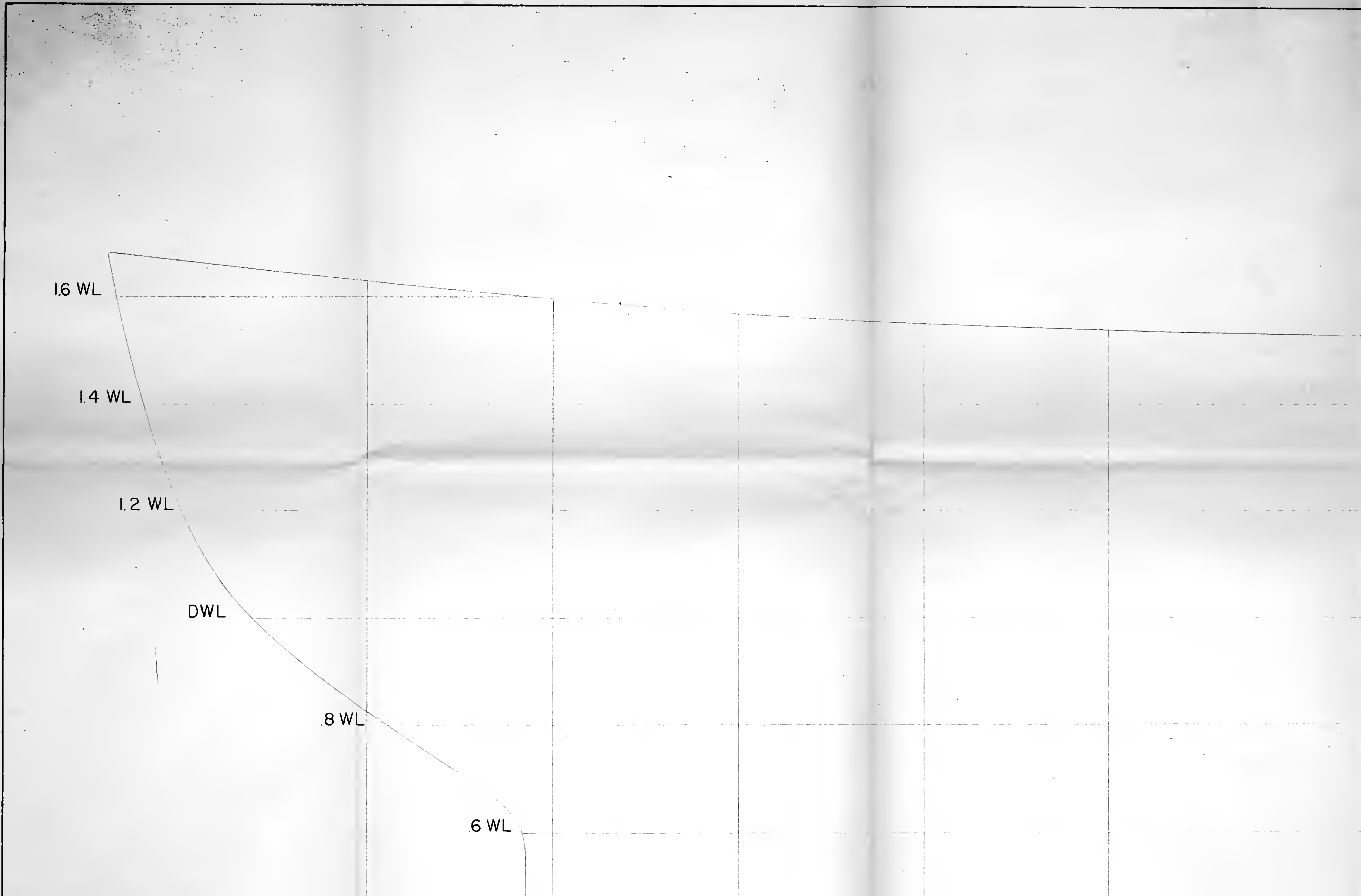
MODEL W-11

SCALE - FULL SIZE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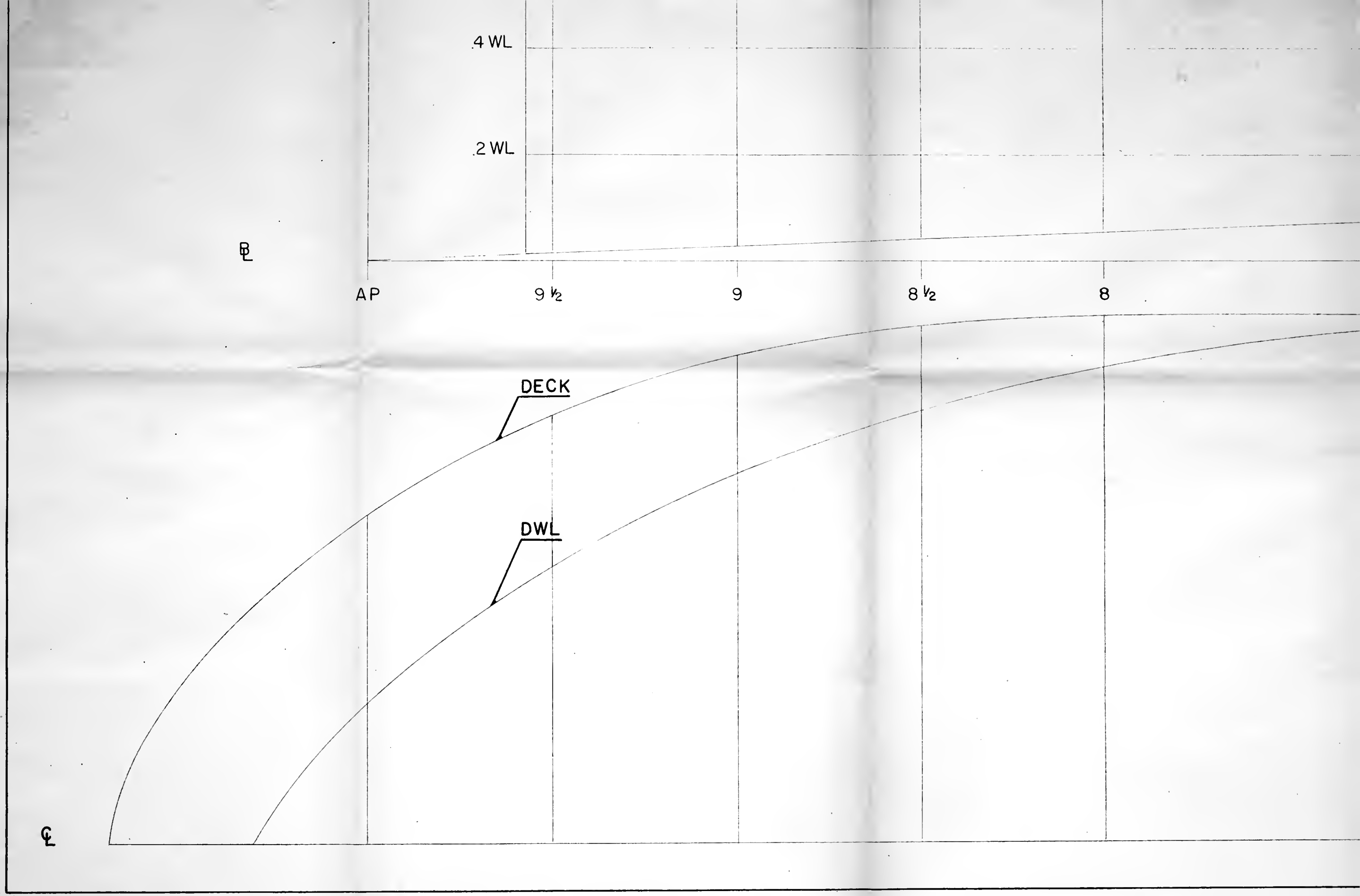
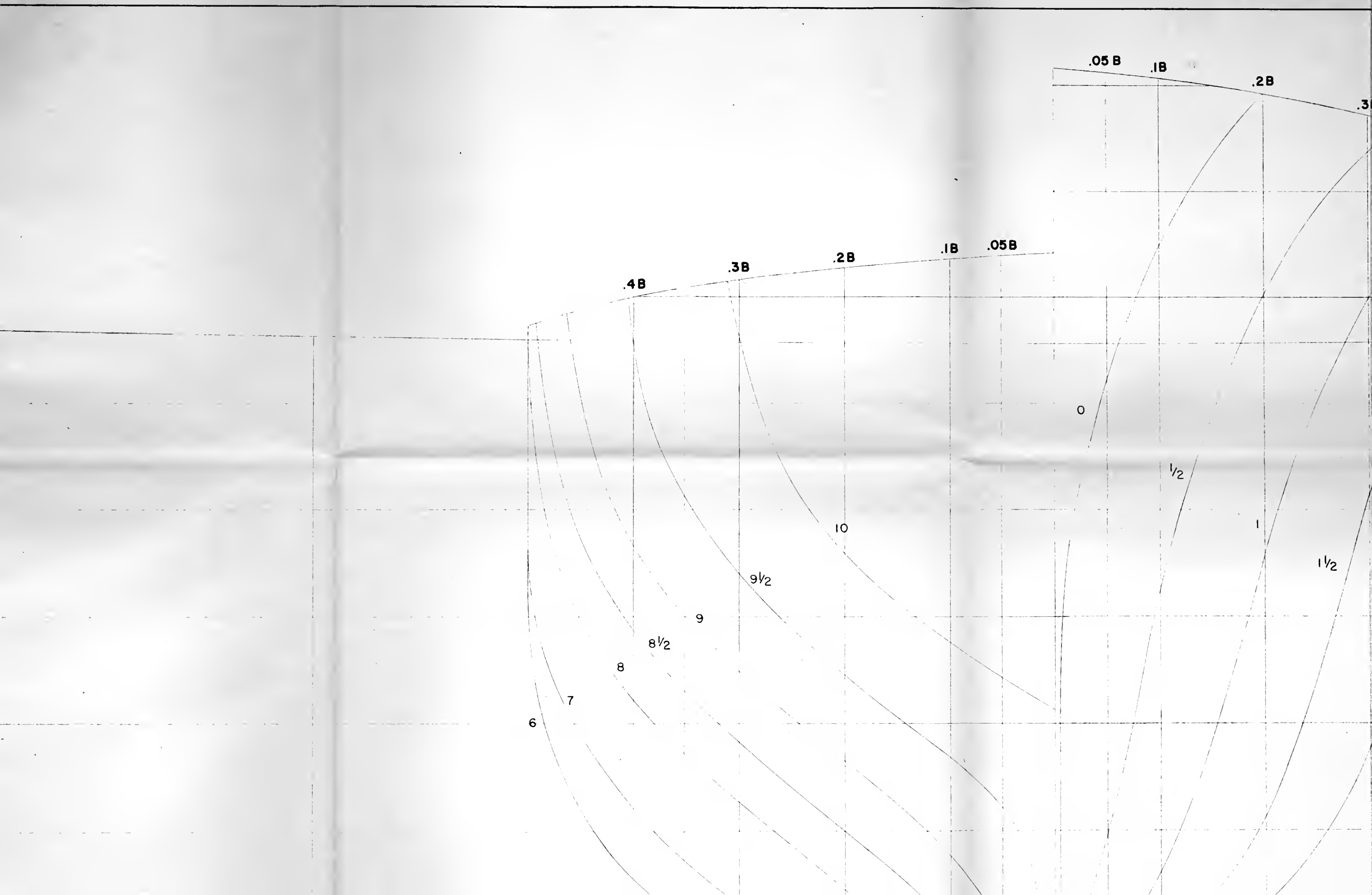
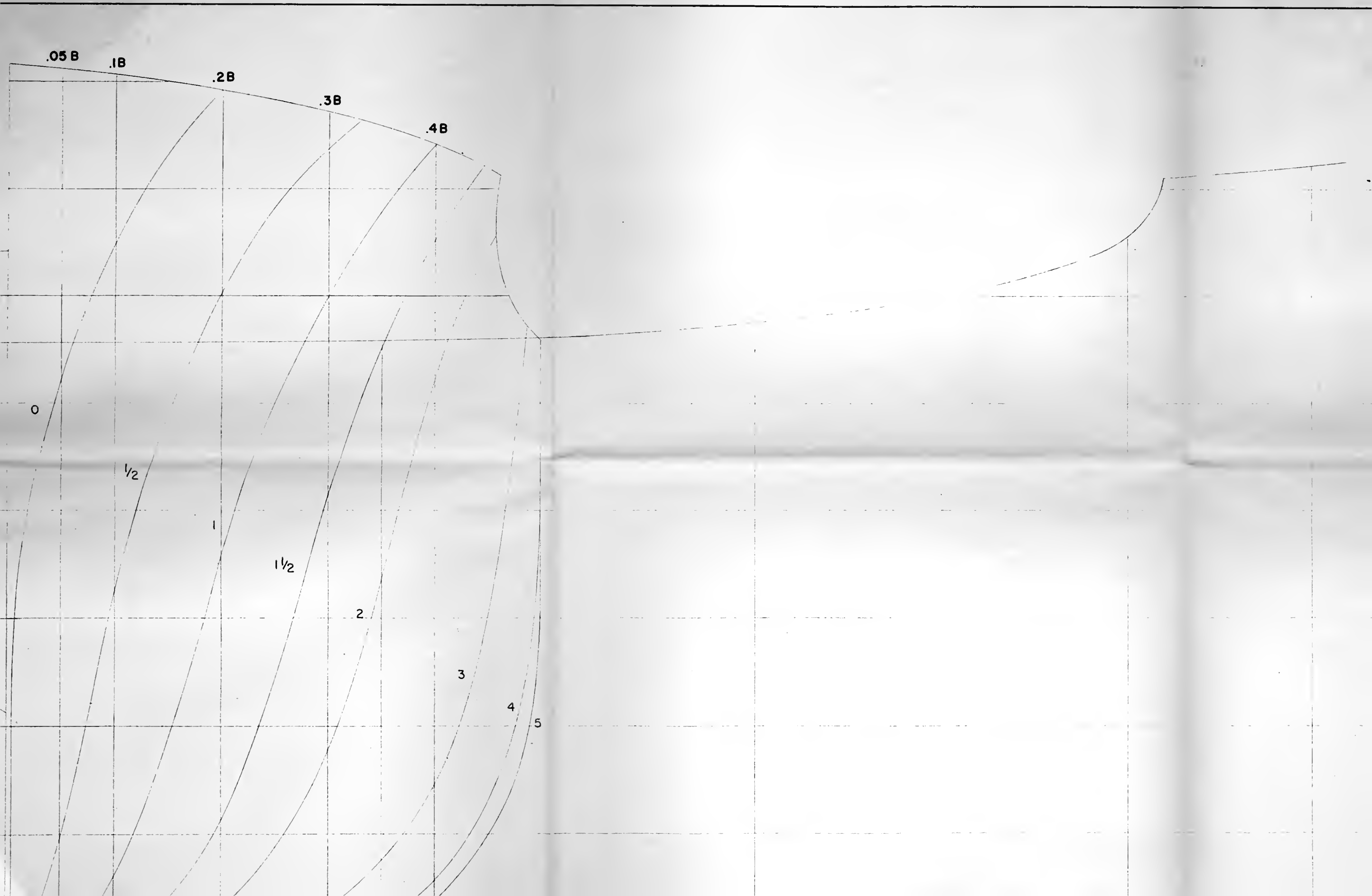
1.2 WL
DWL
.8 WL
.6 WL

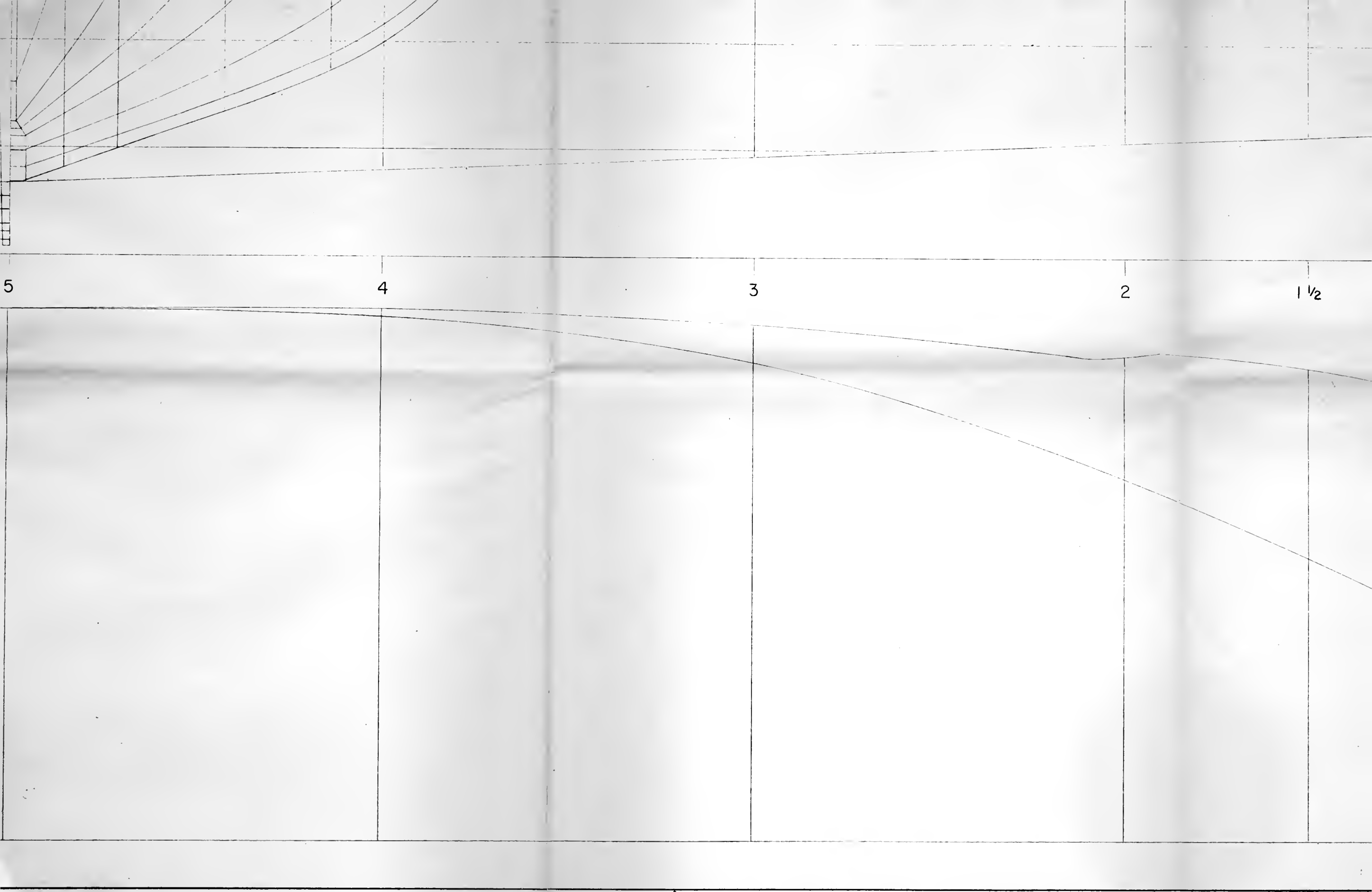

.4 WL
.2 WL
BL
AP
9 1/2
9
8 1/2
8
DECK
DWL
CL

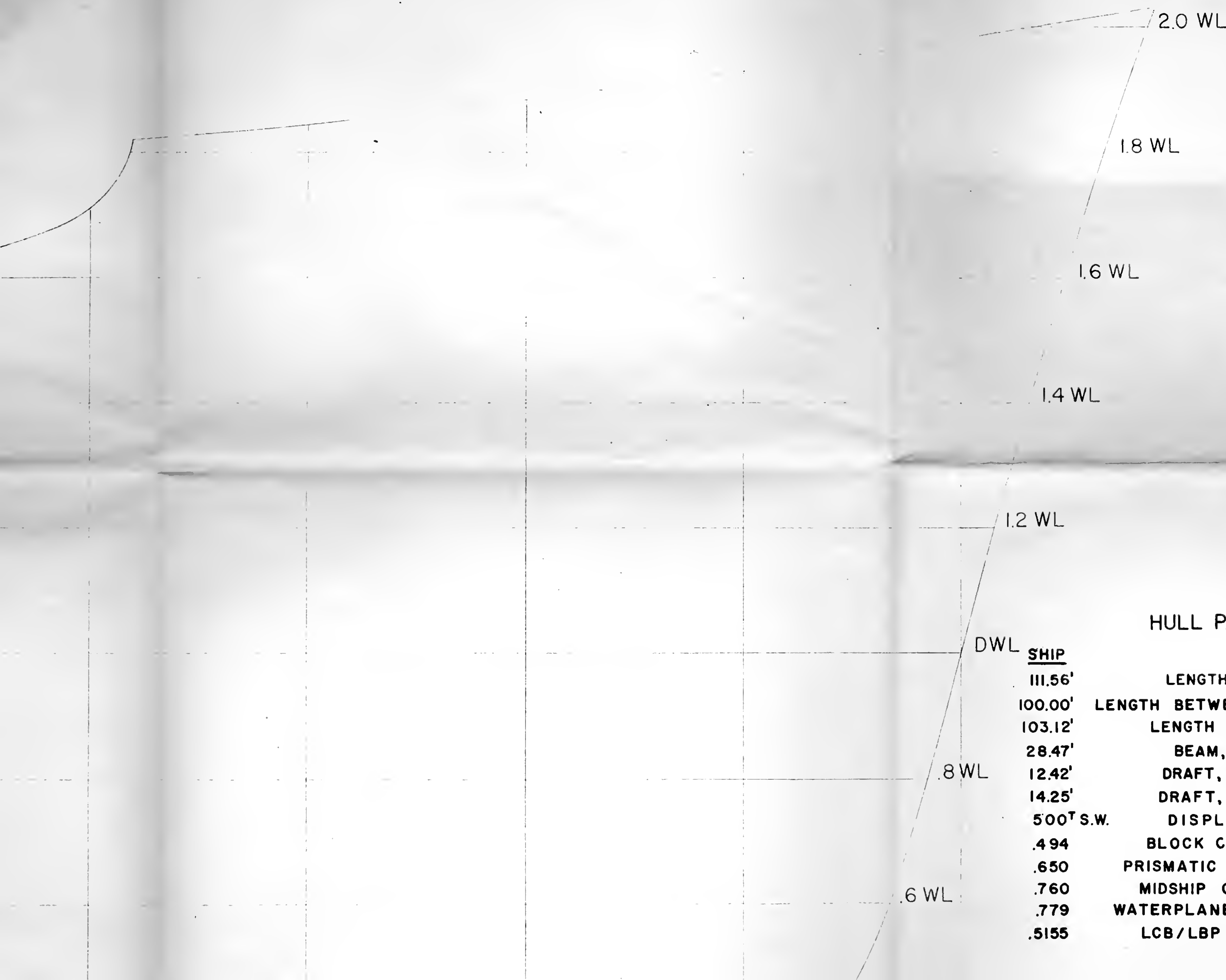


.05 B
.1B
.2B
.4B
.3B
.2B
.1B
.05B
0
1/2
1
1 1/2
10
9 1/2
9
8 1/2
8
7
6


7
6
5


.05 B
.1B
.2B
.3B
.4B
0
1/2
1
1 1/2
2
3
4
5


5
4
3
2
1 1/2



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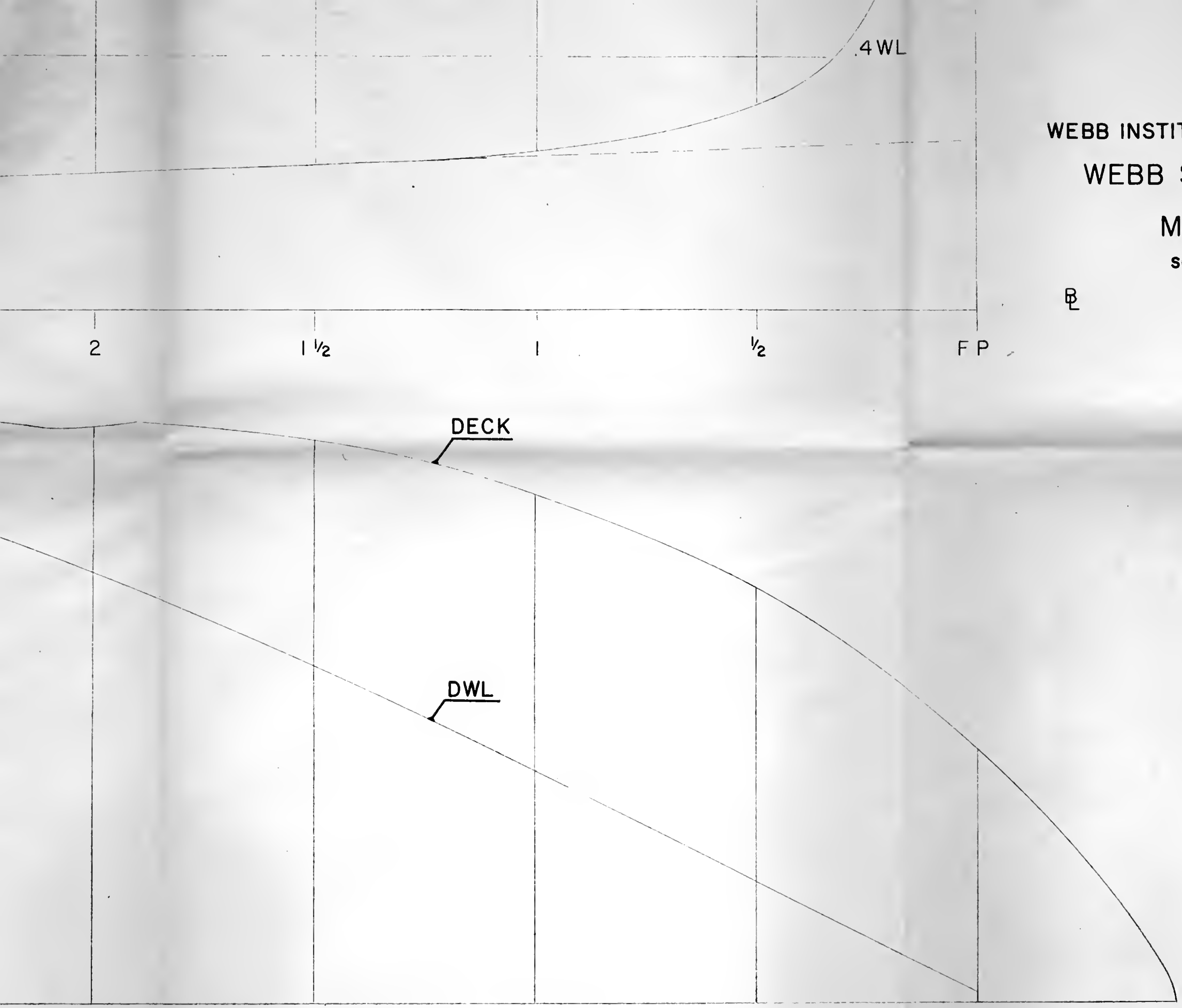
HULL PARTICULARS

SHIP		MODEL
111.56'	LENGTH OVERALL	53.55"
100.00'	LENGTH BETWEEN PERPENDICULARS	48.00"
103.12'	LENGTH WATERLINE	49.50"
28.47'	BEAM, MOLDED	13.68"
12.42'	DRAFT, MOLDED	5.94"
14.25'	DRAFT, EXTREME	6.84"
5.00^T S.W.	DISPLACEMENT	69.67 # F. W.
.494	BLOCK COEFFICIENT	.494
.650	PRISMATIC COEFFICIENT	.650
.760	MIDSHIP COEFFICIENT	.760
.779	WATERPLANE COEFFICIENT	.779
.5155	LCB/LBP AFT OF F.P.	.5155



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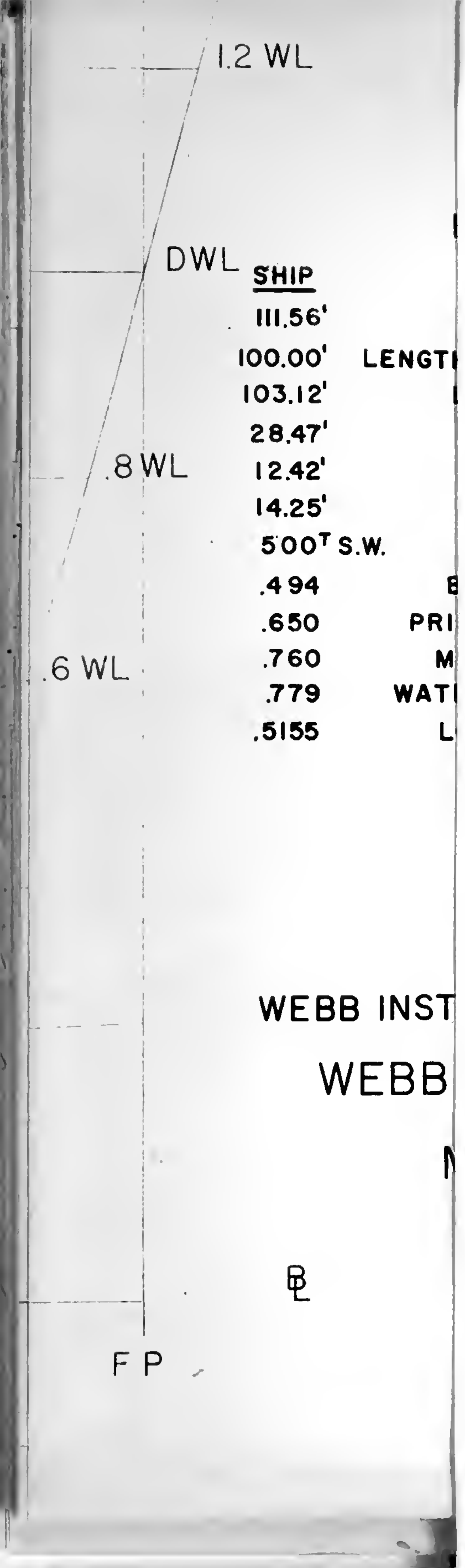
WEBB STANDARD SERIES

MODEL W-12

SCALE - FULL SIZE



C507 Claytor 23966
The resistance of trawler hull forms of various displacement-length ratios at 0.65 prismatic coefficient.